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SCIENCE AND CULTURE

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The Next Twentyfive Years of Science in India

WITH the present number, SCIENCE AND CULTURE steps into the fourth year of its existence, and we take this opportunity of discussing the future of Science in this country within the next twentyfive years. This is a natural sequel to the review of *the Progress of Science in India within the Past Twentyfive Years* (published by the Indian Science Congress Association on the occasion of the Silver Jubilee) which will appear in a later issue. Our readers may ask themselves the question: What will be the progress of science within the next twentyfive years, when the Indian Science Congress will celebrate its Golden Jubilee?

Many people in this country may ask whether further expansion of science is at all needed in this country? This question has been answered by our national leader Pandit Jawaharlal Nehru in his message to the Silver Jubilee Session of the Indian Science Congress (*vide* Sc. & CUL. 3, 350, 1938).

"I am entirely in favour of a State organization of research. I would also like the State to send out promising Indian students in large numbers to foreign countries for scientific and technical training. For we have to build India on a scientific foundation, to develop her industries, to change the feudal character of her land system and bring her agriculture in line with modern methods, to develop the social services which she lacks so utterly, and to do so many other things that shout out to be done. For all this we require a trained personnel."

If, within the next twentyfive years, scientific spirit is to influence the thoughts and dominate the activities of our leaders, it is clear that it will bring them sooner or later into conflict with Imperialism, vested interests, and time-honoured institutions. But, to quote the words of Stalin, "Science is not science at all if it refuses to call a fetish by any other name except a fetish"—and we need not be afraid of the struggle which the new attitude of the human mind in India will give rise to. For out of these conflicts and struggles will rise the edifice of a richer and a fuller culture, a regenerated India, which will take her rightful place amongst the Nations of the World.

The duty of the man of science in India is quite clear. He will not only have to strive for professional efficiency but will have also to devote a part of his time and energy to the application of science for the reconstruction of human life in this continent. If the performance of the last twentyfive years is an index of capacity, there is no reason to doubt that the Indian man of science will rise equal to the occasion. Let us quote from Dr. W. A. Jenkins (Scientific Education, p. 14 of the *Progress*) about the performance of the Indian scientist within the twentyfive years that have passed.

"The volume of research work which is now being done is remarkable, considering the unsatisfactory nature of

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school and college education, and the financial resources of different educational institutions.''

The burden which is likely to fall on the man of science in India within the next twentyfive years is very aptly expressed in the Presidential Address of the late lamented Lord Rutherford.

"While the Universities of India have in later years made substantial progress both in teaching and research in science, yet it must be borne in mind that still greater responsibilities are likely to fall on them in the near future. This is in a sense a scientific age, where there is an ever-increasing recognition throughout the world of the importance of science to national development. It is natural to look to the Universities and technical institutions for the selection and training of scientific men required for this development.

"In India, as in many other countries, there is likely to be a greater demand in the near future for well trained scientific men. With the growth of responsible government of India, it is to be anticipated that the staff required for the scientific services in India and for industrial research will more and more be drawn from students trained in Indian Universities. These men will be the future leaders of research both in Universities and in scientific research organizations, and for their proper training it seems essential that the defects in the present-day system of education should be remedied at as early a date as possible.''

The defects of the present system of scientific education have been very ably analysed by Dr. Jenkins in his article on the "Progress of Scientific Education in India" (p. 1-17). A few extracts will bring out the essential points, but we recommend to our readers a careful study of the whole article. According to Dr. Jenkins, even in the West, it was at first believed that science had no cultural value, but it was tolerated as a subject of study on account of commercial and industrial demands. Such demands have been so far very largely absent in India.

"But even in the West, it has now been recognized that, even for students who intend when they proceed to the Universities to follow a classical or non scientific course, school education must include teaching upon the general principles of science as they find expression in an elementary knowledge of such subjects as Physics, Chemistry, Biology, Botany, Physiology, Astronomy, etc......''

Why has this change of attitude come upon the West? It is because men have now been convinced that the culture of to-day and to-morrow must be based upon the changing world picture of science.

This changed outlook is all the more necessary in India, because if this country is ever to enter the path of progress, her younger generations must be cut adrift from many medieval ideas and traditions which are instilled into their minds in the name of religion, philosophy, custom, tradition or history. Only a good dose of scientific education can undo the evil influences to which young minds are subjected. Further, science, insisting on the combination of manual and brain work as the only sure road to progress, can undo the mischief which the social structure of this country has wrought upon the minds of all classes of people, *viz.*,—undue exaltation of idle and speculative brain work, and relegation of all manual workers to an inferior status in society. Progress, as the example of the last few hundred years has shown, depends upon equal partnership of the brain and the hand, an ideal which must be set up before the country.

We hope that the Governments and educationists in this country will profit by Dr Jenkins' sound recommendations. But even supposing that these recommendations are accepted, that the foundations of a sound scientific system of education are laid in the schools, colleges and universities, and that the country is provided with a new generation, well-grounded in science, it is almost certain that such education will be futile unless fields are created where the services of such men can be utilized; otherwise under the present condition of the country, we would be preparing good seeds only to throw them in the wilderness. It is very necessary to realize that education, being the preparation of the individual for the service of the community, will be quite useless unless the educational system is conceived as part of the larger question of the regimentation of the population into different professions.

Earlier in this journal, we have quoted largely from the Presidential Address of Prof. M. N. Saha to the National Institute of Sciences, (Sc. & Cul. *3*, 4057, 1938) to show that it is impossible to solve the problems of poverty and unemployment in this country, and lay the foundations of a healthier cultural life without a large-scale industrialization of the country.

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India possesses sufficient mineral and power resources to enable her to be industrialized to the same extent at least as France or Germany. What is wanting is lack of vision on the part of the Government and the leaders. We are being constantly told by the Central Government that India's problems can be solved only by improvements in agriculture, while the Congress has raised the slogan of rural improvement. The Government of India have founded an Imperial Council of Agricultural Research, but they have not shown any enthusiasm for the establishment of a National Research Council composed of eminent scientific men of the country which will include a National Council of Industrial and Scientific Research, as one of its constituent bodies.

Let us assume that in course of the next few years this attitude is changed, that both the Government and the political parties of the country are agreed that the solution of India's problems of poverty and unemployment lies in large-scale industrialization of the country, in pooling her resources in power, creating new industries, and reviving the old and decaying ones. It will be similar to the task which confronted the authorities in Russia in 1918, or the rulers of Japan earlier in 1868. If the problems are to be successfully tackled, India, like other countries, cannot depend upon foreign experts; she must create experts and technicians among her own people. The Government will have to look to Indian men of science for advice and guidance, just as Lenin looked to the Russian Academy of Sciences for guidance when he decided to give effect to the various five-years plans. Will the Indian man of science be able to rise to the occasion and shoulder the responsibilities?

Let us see what the task before him is. At present, the most gifted Indian men of science are engaged in academic researches. Thanks to the retrograde policy of the Central Government of putting foreign experts at the head of every department connected with industries, and of an unsatisfactory method of recruitment for these services, the first-class Indian man of science has no opportunity of being acquainted with any industrial problem of the country, except such questions as are connected with agriculture.* When therefore scientific men in India are confronted with such tasks it is natural that they will simply find themselves at sea.

Such moments may arrive earlier than expected, from the event of the next world war it is difficult to see how this calamity can be averted for long. Nations are moving head long towards each other for a collision. The communications of India with the external world are sure to be more severely interrupted than during the last War, and the supply of many commodities for which India has to depend upon foreign countries such as machinery, petrol, motorcars, textiles, chemicals, railway materials, etc., will be stopped or severely hampered. This will violently disturb the course of human life in India, as it did during the Great War, and public opinion will demand that the Government should do something to relieve distress. The Government will then ask† Professors of Physics, Chemistry and other sciences to give them some ready-made formulae for the manufacture of such goods, and when they are found unable to work out the miracle, civilian anger will rise to the boiling point, and proclaim all Indian scientists as incompetent!

Will it not therefore be a good policy to take the warning in time, and create, whether for emergent military needs or for permanent national work, a National Research Council, with a National Committee for Industrial and Scientific Research as one of its component bodies and with a constitution similar to that of the Imperial Council of Agricultural Research, or better on the model of the National Council of Industrial and Scientific Research in the United Kingdom? We have reasons to believe that this course will not commend itself to the Government of India— that they will merely create a department with a director, and

*At the time of writing this editorial, information has reached us that even the constitution of the Imperial Council of Agricultural Research is going to be changed in a way, so that it will be merely a department of the Government of India.

† This actually happened during the Great War, when departments of Industries were suddenly created, and many fortunate professors of scientific subjects were called upon to become directors of industries on fancy salaries. The country does not yet know what industries have been created due to the labours of these departments. They are now mostly under civilian management.

proclaim that their duty has been done.* But our idea of a Research Council is entirely different. It will be a body which will draw up a plan of industrial research extending over years, mobilize the available talents in this country (professors of scientific subjects in the universities and research institutes) by distribution of problems, and help them in their work by the award of adequate research grants. Wherever necessary, new research institutions will have to be created. The problems should be of a country-wide interest, and should deal with the essential points in large-scale industrialization. In this connection, we may quote from the late Lord Rutherford:—

"If the research is to be of real and lasting value, it must be carried out in the interest of the country as a whole and not of any particular province or area. This necessitates careful planning and careful co-ordination of various schemes for research in all branches of science, whether pure or applied. In formulating the future policy, India should profit by the experience of Canada and Australia where the working of the scientific departments of the State or Provincial Governments *vis-a-vis* those of the Central or Federal Government has shown 'that the research organizations of the country should be truly national and responsible to the Federal Government alone'. Even in an Empire, of the size of India, where the resources and needs of various provinces are widely different, it would seem that centralized organization of research is the only way of avoiding waste of money and effort. That detailed planning of research must be in the hands of those with the necessary specialized knowledge, and they must be able to act without suspicion of political or racial influence."

Commenting on the above, Dr. Baini Prasad, General Editor of the *Progress of Science in India* says:

"A review of the past and present conditions affecting the progress of Science in India clearly shows that for a proper and efficient performance of the functions of scientists, as outlined in the above quotation, the constitution of an independent body of properly qualified and experienced men is essential. In other words, a plea is made for the foundation in India of a National Research Council on the lines of the body which ever since its constitution has been rendering such useful service in Great Britain. The functions of this council should not only include the defining of scientific policy but it should also act as an expert advisory body for planning and co-ordinating all scientific research in the country. The planning of scientific policy and co-ordination of research should be so arranged as to preclude duplication and avoid wastage of talent and available funds, but without restricting the normal work of universities, scientific departments and institutions, or in any way curbing individual initiative which is so essential for high class research. Such an authoritative body should also be able to help in bringing about the necessary reforms in the existing system of scientific education. In order to ensure that the work of the council is not hindered by any extraneous circumstances and that the steady progress of scientific work, so essential in the cause of the advancement of the country, is maintained, it should be liberally endowed by the Central and Provincial Governments and by the public so as to be independent of annual appropriations for the carrying out of its programme of work. The above functions are somewhat similar to the objects of the National Institute of Sciences of India founded at Calcutta in 1935 and probably the existing machinery of the National Institute could easily be transformed to take on the functions of the proposed National Council of India." (*pp. lv-lvi.*)

Now to sum up:—the persual of the *Progress of Science in India* tells us that though the ancient Indians showed remarkable aptitude for scientific investigation and made quite creditable contributions to sciences like medicine, chemistry, mathematics and astronomy, they had lost by 1200 A. D. the art of independent thinking. At this time, India passed under Turkish rule, and her indigenous culture came into conflict with a new culture which, though it had made creditable contributions to knowledge in other countries, showed itself extremely barren on Indian soil. There was none, amongst the Muhammedan scholars of India, who can be compared in actual scientific achievement to Avicenna, Geber, Mohammed ibn Musa, or to an Omar Khayyam. But the Indian capacity for scientific research lay only dormant, and under the present settled government, has shown signs of coming again to full bloom.

Three stages can be perceived in the growth of scientific research in India: (*i*) The first contributions were made in connection with administrative needs—This led to the foundation of the scientific departments of the Government of India, *viz.*, the Trigonometric Survey (1818); the Geological Survey (1845); the Meteorological Survey (1864) etc. (*ii*) The next phase came with the recognition that teaching of science should form an essential part in the curriculum of schools and universities, and that university teachers

*There is already in existence a department of Industrial Research Bureau, but this does not serve our purpose. The Government has just given us an air-gun, where a howitzer was needed.

should have ample scope for carrying on research work on basic sciences. (*iii*) The third phase came with the tardy recognition on the part of the Central Government that scientific research is essential for national economy, particularly for agriculture and industries based on agricultural products (cotton, jute, sugar). The Government has not yet recognized that the large-scale industrial development is absolutely necessary for the solution of India's problem of poverty, unemployment, as well as for defence, but to anybody who has given serious thought to this subject, no other course can commend itself. The next phase in scientific research will commence when the Central and Provincial Governments recognize this fact, and embark on a policy of autarchy, *i.e.*, production of all industrial goods, as far as possible, in this country, with Indian capital and labour. Such production will include many goods for which India has now to depend entirely or partly on foreign countries, *e.g.*, textiles (cotton, silk and wool), railway materials (engines, wagons), motor cars and motor spirits, goods made of metals, glass, both heavy and fine chemicals, medicines and all offence and defence armanents. She will have to start industries which are now absent in India, *viz.*, the power industry and shipping industry. For a successful realization of this policy, it will be necessary to mobilize all the scientific and technical talents of the country through the creation of a National Research Council.

Let us hope that this policy will be adopted in future, and when the time comes for the celebration of the Golden Jubilee of the Indian Science Congress, twenty-five years hence, Indian scientists would be found to have made glorious and fundamental contributions not only in basic sciences, but also in industrial research, and thus contribute substantially to the reconstruction of human life on this continent on sound, scientific lines.

Scientific Education in India

There are more virgin and wider fields in subjects like Botany, Geology, Physiology and Bio-Chemistry than in the more frequently trodden grounds of Physics and Chemistry. Moreover, in many of these branches well-equipped and expensive laboratories such as are available only in the large colleges and towns are not essential for the production of valuable work. These are directions in which men of genius in small colleges and residing in the rural areas should find an opportunity for explorations of value during their leisure time and in their immediate surroundings. Research work encounters many difficulties in this land which are absent in others. At the present moment it is only men of undoubted genius who are able to triumph over the difficulties which are encountered. The greatest inherent difficulty is the lack of a sound fundamental education. It is the business of educational authorities to minimize these difficulties and to provide satisfactory accommodation and facilities and efficient teaching. It is the business of the commercial and industrial firms, which stand to gain by the results of research work, to make possible the building and equipping of laboratories and the carrying out of work upon problems, the solution of which is to their advantage.

Jenkins, ***Progress of Science in India during the Past Twentyfive Years.***

Upper Air Meteorological Investigations and Radio Meteorographs

R. R. Bajpai

Introduction

The importance of meteorological observations in the upper atmosphere has recently been growing very rapidly. The data yielded by these observations are not only of vital significance to all the phases of the science of meteorology, but have also got important applications in other fields where they are put to immediate practical use. Commerce, industry and the military need them all alike. A successful air service depends on the knowledge of aerological conditions. Armies in the field require quick and reliable information about the upper atmospheric conditions in connection with their plans of manoeuvre and operation of aircraft, artillery and chemical warfare. The recent successful application of these data in daily weather forecast has given these observations another vital practical significance over and above their scientific value. The daily growing need of these data in connection with the multifarious uses to which they are put makes it necessary that regular upper air meteorological observations should be carried out during the day as well as at night and under all conditions of weather foggy, cloudy and clear.

Sounding Balloons

The scientific explorations of the upper atmosphere began with the use of kites and captive balloons. They were, however, soon replaced by balloon-sondes or sounding balloons which still retain their traditional position as one of the most efficient means of studying the upper atmosphere. They are extremely valuable as they furnish continuous records of pressure, temperature and humidity up to heights sufficient for our practical needs. But they have their disadvantages too. The most outstanding disadvantage of the method consists in the considerable time that elapses between ascension and recovery of the meteorograph carried up by the balloon. These meteorographs are frequently not recovered until weeks after the ascension and sometimes are never recovered at all on account of getting drowned into the sea or descending to an unfrequented area (just as it happens at the Upper Air Observatory, Agra, where the percentage of recovered balloons is only about 30) from where nobody brings them back. Thus sounding balloons cannot be used where quick information about the upper-air conditions is required. They are out of question for daily weather forecasts and cannot serve any useful military purpose where a delay of hours and even minutes may prove fatal. Even as a means of purely scientific study, where we may neglect the time factor, the use of these balloons is rather limited, for it is not practicable to use them for obtaining measurements over sea and in isolated tracts of land.

Pilot Balloons

Pilot balloons which carry no instruments for recording the meteorological elements also form a regular part of the meteorological equipment for obtaining the wind velocity and wind direction in the upper layers of the atmosphere. These balloons are observed by means of theodolites, and it is from the readings of this instrument that the above-mentioned characteristics of the upper winds are computed. But these observations are possible only so long as the balloon remains visible from the ground. Thus no high-wind measurements can be carried out on days of poor visibility and bad weather. And how to obtain observations at night? For such observations a small paper lantern illuminated by a candle is attached to the balloon. But here again the method fails when clouds, fog or

other conditions of poor visibility prevail. Moreover, there is a danger of fire if a faulty balloon lowers the lantern into some inflammable material.

Methods depending upon Sound Measurements

During the Great War need was felt of having upper-air observations of wind velocity and wind directions under all conditions of weather and a number of methods depending upon sound measurements were developed and used. In one of these methods a small bomb with a time fuse is attached to the balloon and after the explosion takes place, sound-ranging measurements are carried out. The sound-ranging installation consists of a network of a number of microphones arranged on two lines at right angles to each other. There is a central station to which all the microphones are connected. The sounds picked up by the various microphones are recorded on the same paper at the central station where all the results are reduced and balloon positions determined. In actual working the balloon is first inflated, a rough estimate is made of its ascensional rate and a bomb is attached with a suitable time fuse. Then it is carried windwards and released at such a distance that by the time it reaches over the network of the microphones the bomb explodes. Making use of this determination of wind speed and wind direction, another balloon is prepared and let off at such a place that the bomb carried with it explodes at a level higher than the first and, of course, roughly over the network of the microphones. In this way the process is repeated a number of times, taking care that every time the bomb detonates at a level higher than the previous one. Apparently, the method is very tedious and expensive and is also subject to a serious drawback that a period of several hours is required for one computation. Within this period considerable change in wind velocity and direction may take place. Thus the method is neither accurate nor quick and is of no use for scientific investigations as well as for any other purpose where quickness counts. Another serious criticism levelled against this method is that a faulty balloon may deposit the bomb in an area where it may cause considerable damage to life and property. Examples of such occurrences are not wanting.

Another method of taking observations of wind velocity and direction in the upper air under conditions of poor visibility consists in firing balls in a vertical direction and noting the point of fall on the earth. An estimation of wind direction and speed is then made from their effect in deflecting the ball from its vertical course. A series of shots are fired using different amounts of charges so that they may reach successively higher and higher levels.

Air-plane Ascents

Weather reports from air-plane ascents were introduced soon after the War and, at present, these ascensions have taken the place of all other methods of upper-air explorations, so far as regular soundings up to a height of 6 or 7 kms. are concerned. The ascents have proved invaluable in bringing back all sorts of data up to these limited heights. But the aerological airplane assents are very expensive and thus the meteorologist today has to be satisfied with a number of flights much less than what is necessary. Again, no matter how daring the pilots, the aerological plane ascents cannot be made when the weather is badly stormy, and there is a risk of life. Often in bad weather, the planes get lost and are unable to bring back reports in time. However, it is in such bad weather that a knowledge of the conditions of the upper air is most needed.

Radio Meteorometric Equipment

The preceding narrative makes it clear that a method for recording meteorological elements in the upper atmosphere which may be quick, reliable, capable of being used in all conditions of weather—cloudy, foggy, or clear and able to bring meteorological messages from inaccessible places, was badly needed.

The meteorologist realized that almost all these requirements could be fairly met with by using a small radio transmitter attached to a sounding balloon and making it radiate the upper-air data. These could be received at the ground, and information concerning successive levels could easily be gathered during the ascent of the balloon. This resulted in the development of the present-day radio-meteorometric equipment. The subject is of

very recent origin and the whole development has been made after the War. The first attempts at wireless transmission of upper-air data from a captive balloon were made in France in the year 1918, but without success. Similar was the fate of some experiments made in Germany in the year 1923 with a buzzer driven oscillator attached to an unmanned balloon. It was Blair in the United States of America, who for the first time succeeded in tracking a balloon for a period of about 20 minutes. Later, in the year 1927, Idrac and Bureau successfully used a 42-meter wave electron tube transmitter attached to a sounding balloon. It was, however, Moltchanoff, a Russian scientist, who for the first time in January 1930 succeeded in accomplishing a radio sounding in the stratosphere, and since then the subject has been developing by leaps and bounds. The progress is due chiefly to the efforts of Vaisala in Finland, Bureau in France, Duckert in Germany and Moltchanoff in Russia.

A radio-meteorometric equipment is furnished with instruments to measure the meteorological elements at certain points and transmit them to some other more conveniently situated station where they may be recorded. The end in view has been the construction of sensitive and accurate instruments capable of being used with sounding balloons. They can be sent up by airplanes also when there is an urgent need of the knowledge of the upper-air conditions. What we want is a continuous record of the upper-air data, and it is to this end that all our efforts are directed. The meteorometric equipment can be divided into four sections, *viz.*, the balloon, the meteorograph, radio transmission, and reception.

We require a record of upper-air data in as vertical a direction as possible. Hence the lifting power of the balloon should be much in excess of that required for merely lifting up the equipment so that a rapid ascent may be ensured. This will also ensure a good signal strength, for the distance between the transmitter and the receiver would not become too great. The greater rate of ascension is not, however, without its demerits, inasmuch as an increase in this rate reduces the number of readings of the meteorological elements at a given height. Another point to be considered is the air resistance, and the balloon should be so designed that it should be capable of having the required lifting power with minimum air resistance. In practice, instead of one big balloon, a number of small balloons are used. This reduces the cost also to a considerable extent. The resistance is still more reduced by tying the balloons in a vertical line. The equipment is provided with a parachute in order to avoid injury to the public and for safe landing of the equipment.

The Meteorograph

A schematic diagram showing the principle of a radio meteorograph is given in Fig. 1. A contact arm A rotated by a clock-mechanism turns round a centre with a constant angular velocity making one complete revolution in 30 seconds or a minute as

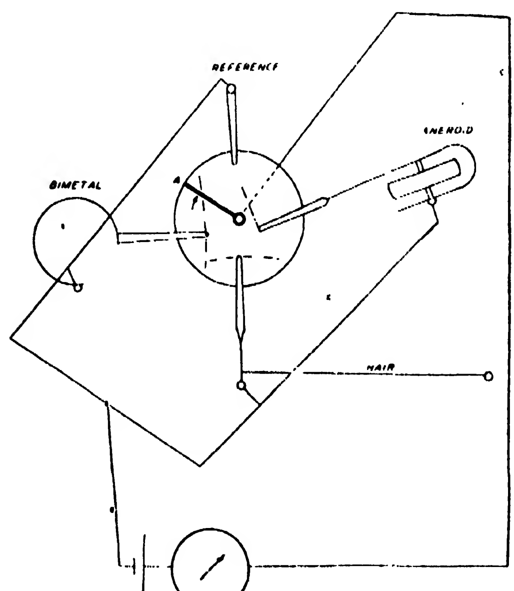

Fig. 1

the case may be. In the Blue Hill Observatory radio meteorographs, the rotor used is a brass rod embedded in a bakelite disc. This was, however, later replaced by a metallic helix embedded in a cylinder made of some insulated material. The rotation of the clock is synchronous with that of the recording chronograph. The rotor A is furnished with a light

spring for the purpose of making electrical contacts with arms operated by a bi-metallic thermometer, by a hygrometer and by an aneroid barometer during its passage over them. Each of these arms describes an arc over a portion of the circular face. In a thermo-hygrograph generally an arc subtending an angle of 120° at the centre is allotted for each pen, which may be varied according to necessity. The moving arm makes contact with a reference pen also once during every rotation. This serves as a time reference. Each of these contacts may either be used to make or to break an electric circuit during the period of contact and thus allow the transmitter either to radiate or to cease to do so during the time. As a continuous tone is easier to follow, the contact is used to make the transmitter cease to radiate during the period of contact. Thus the contacts are sent out and are received at the receiving station. The time between similar contacts indicates the position of the pointers and provides us with a measure for the various meteorological elements. The clockwork is fitted with an invar balance wheel so that the temperature changes may be compensated for and the contact arm may rotate with a constant angular velocity. However, in practice a constant speed is not realized, which presents a troublesome problem, and fan drives have been experimented with to replace the clocks. The radio unit is shielded from moisture and the thermometer from direct radiation.

The first problem that draws one's attention in this connection is the choice of wavelength. The choice should be such that radio energy may be easy to generate. Power consumption should be small and signal strength sufficiently large. The weight of the equipment should be as small as possible and static interference at its minimum. Previously wavelengths from 20 to 150 meters were used. Chief advantage of this range is easy generation of oscillations. But when consideration is given to the weight of the equipment, it is easy to see that ultra-short waves are the best. Interference from atmospherics also is not troublesome at these frequencies whereas on the longer radio-frequencies mentioned above it will be well nigh impossible to work in tropical latitudes specially during summer. The ultra-short waves are also able to cover large distances with low power. On the longer waves there is also the serious question of interference from communication signals as well as interference with other regular services by signals transmitted from the sounding balloons. Thus it appears best to use the shortest waves possible for radio sounding work, provided other considerations do not make them prohibitive.

The chief consideration in the transmitter is the choice of the tube. It should have a low filament power consumption, should be able to generate waves up to 1 or 2 meters in wavelength, and should be as light as possible. Due to the use of the ultra-short waves circuit constants are much reduced in size, which results in a considerable reduction in the weight of the equipment. Any of the conventional oscillatory circuits may be used. The plate power is generally supplied by the buzzer-transformer. A serious difficulty, however, met with the buzzer is that it sticks in operation.

The batteries used should be as light as possible but the weight of the batteries cannot be reduced without decreasing their capacity. They must be able to supply power for at least 3 or 4 hours. The chief difficulty met with the batteries for use at great heights is the low temperatures prevailing there. Use of thermal insulators and heat-generating compounds has been suggested in this connection.

Receiver and its Accessories

As the transmitters used in radio sounding work are simple oscillators, which are not sufficiently stable, reception on superhets becomes rather difficult. What is required is a set with broad tuning. Hence, generally for work on these ultra-short waves, super regenerative receivers are used. But there are several disadvantages in the use of such receivers. For example, they have got a high noise level, thus requiring a stronger signal, and are less sensitive. Further super regenerative receivers, when used in close vicinity of each other, interfere badly, which creates difficulties in direction-finding. Recently superheterodyne receivers for use with radio meteorographs have also been developed.

At the Blue Hill Observatory recording is done on a chronograph synchronized with the rotation of

the contact arm on the meteorograph. When the drum completes one rotation the recording pen gets lowered, thus the successive lines get separated by about 2 mm. As soon as the relay on the recording comes to a close, a circuit of the pen magnet closes. This causes the pen to make a mark on the paper. If the timing signal from the sounding balloon comes at the same point on the chronograph drum, but 2 mm. lower at each revolution, a straight vertical line would be formed, provided the meteorograph and the chronograph are in synchronization with each other. Fig. II shows a rotating drum on the left and the type of record obtained with a standard radio-meteorograph on the right.

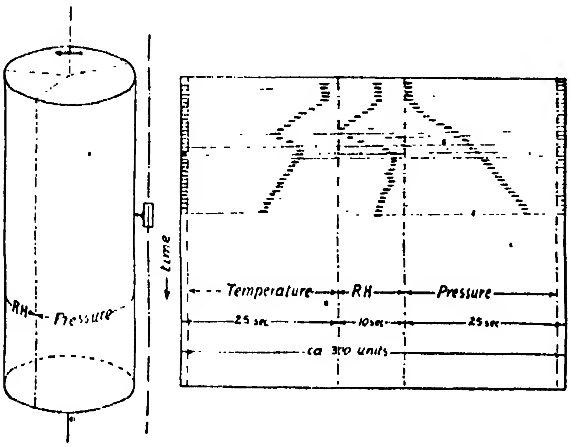

Fig. II

A Comparison of the Constant and the Variable Frequency Radio Meteorographs

According to the working principle employed, the radio-meteorographs fall into two classes, *viz.*, the constant frequency type and the variable frequency type. In the former the radio-frequency signals representing single headings of the various meteorological elements are transmitted in rapid succession, the transmitter working at a fixed frequency. Thus the instrument does not furnish us with a continuous record of any of the meteorological elements. This is the principle employed in the radio meteorographs of Bureau, Moltchanoff, and those developed at the Blue Hill Observatory in the United States of America. The latter type of radio meteorographs make use of a variable radio frequency for expressing the changes in any of the meteorological elements. Thus we can get a continuous record but only for one of the elements. However, if we want to record other meteorological elements also, additional signals on a variable frequency are required or the transmitter may be switched successively from one element to another, in which case the record will not be continuous and we shall get only single readings in rapid succession as are obtained in the former type of radio meteorographs. At present, in the constant frequency radio meteorographs great accuracy and rapid succession of readings cannot be attained at the same time and a compromise has to be made between the two, whereas the variable frequency type of instruments can furnish as with continuous records, though only for one of the elements.

The constant frequency type of radio meteorographs require only a small band width for successful operation and the question of interference with other regular services is not very serious. The variable frequency instruments, on the other hand, require a band width of about 1000 kc., and suffer from a great handicap as regards interference.

The variable frequency radio meteorographs suffer from another disadvantage that these instruments have to be calibrated along with their transmitters. Hence a radio receiver has to be used for obtaining calibration data and great care is necessary in order that the calibration of frequency in terms of meteorological units may not change during the time that elapses between the calibration and actual sounding. In the constant frequency radio meteorographs temperature, pressure and humidity tests can be carried out without the radio part of the instrument and any number of meteorographs can be calibrated at the same time, provided that they can be accommodated by the calibration chambers and that there is a sufficient number of electrical connections available between the chamber and a recorder. Once the calibration is done, any meteorograph can be connected to any transmitter for actual sounding. The measurements in the constant frequency type of radio meteorographs can be

directly recorded, while in the other type of instrument they have to be made by an observer, which is certainly not very convenient.

from one another. This arrangement closes circuit of the transmitter and makes it radiate three signals at constant intervals during one revolution. Between every two of the three lugs moves the pointer of one of the meteorological elements pressure, temperature and humidity. Let us take

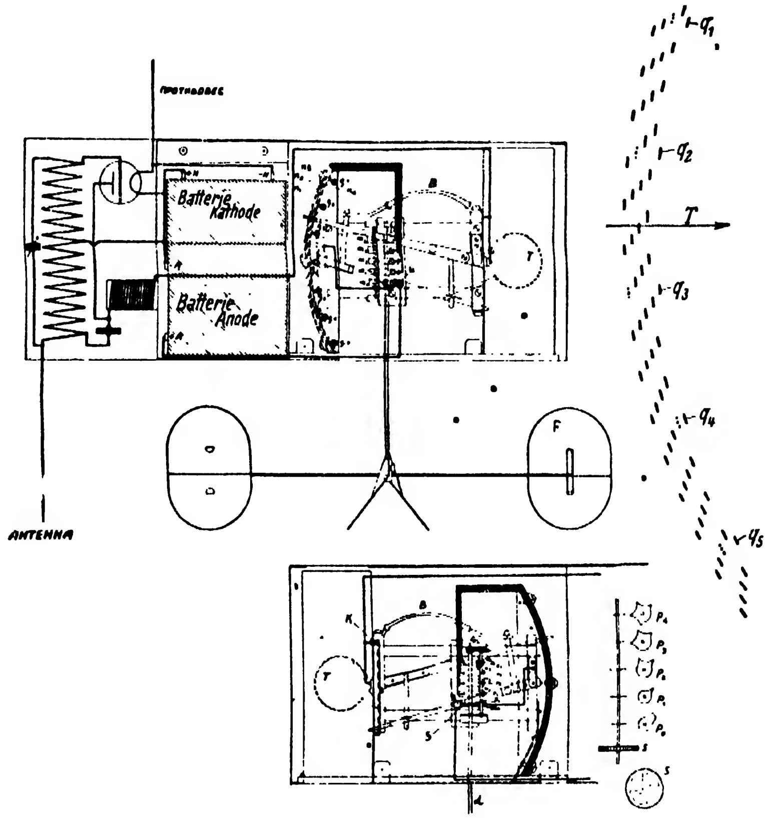

Fig. III

The Constant Frequency Radio Meteorographs

(*a*) *The Askania Radio Meteorograph.*—This instrument was used by Moltchanoff and Weickmann in the Arctic expedition of the airship 'Graf Zepplin' and became famous since then. The principle is essentially the same as explained in the general note on radio meteorographs.

A contact arm is revolved by a clockwork in such a manner that during the period of each revolution electrical contact is made with three lugs, arranged on a circle at an angular distance of 120°

the temperature pointer. It will approach one lug or the other as the instrument passes through regions of high and low temperatures. The revolving arm of the clock also makes contact with the temperature pointer and makes the transmitter radiate a fourth signal. During the passage of the instrument through regions of higher temperature this signal will come shortly after the signal of the lug one, but when it meets lower temperatures—the time interval between the temperature signal and the reference signal increases. A calibration is necessary for supplying the correlation between

the two. The two remaining factors are similarly made use of for pressure and humidity. The recording of the signal at the ground is easy and has been explained before.

The chief feature of the instrument is its simplicity but it suffers from several disadvantages affecting accuracy. Firstly, the clockwork of the instrument does not run at a constant speed on account of the changes of temperature and air-density necessarily met with during the course of a sounding; secondly, the subdivisions of the time-scale of the instrument are definitely limited, for the clock does not drive the contact arm uniformly and smoothly.

(b) The 'Kammgerät' of Moltchanoff. It is a very widely used radio meteorograph. Kammgerät means a comb apparatus. Fig. III gives the essential features of the instrument. *T* is a bi-metallic thermometer actuating a pointer by means of enlarging linkages. The pointer glides over a system of electrical contacts which consist of four rows of contacts n_1, n_2, n_3 and n_4, arranged in such a manner that the pointer, regardless of its position, touches only one of them. There is an electrical connection among the contacts of the row n_1 and also among those of n_2, n_3 and n_4, but the four rows are insulated from one another. Four metal combs, the spaces between the teeth of which are three times as wide as the teeth, may be used Every one of these combs is connected to a flat spring, m_1, m_2, m_3 and m_4. The springs are arranged opposite small contact discs, p_1, p_2, p_3 and p_4. A shaft *cd*, rotated by a fan, carries these discs, which are so shaped that during the course of a single revolution they touch their springs once, twice, thrice or four times respectively. Now this whole arrangement is put in the *B* battery circuit of the transmitter, the shaft and the pointer forming the two terminals Obviously at the time of a contact the transmitter radiates a signal corresponding to the Morse sound of *e*, *i*, *s* or *h*, depending upon the position of the pointer on the comb. If the instrument travels from a region of higher temperature to another of lower one, successive signals of *h*, *s*, *i*, *e*, *h*, *s*, *i*, *e*, etc., will be radiated, but if it enters regions of increasing temperature the order of the signals will be changed to *e*, *i*, *s*, *h*. The correlation of temperature and changing of signals is furnished by means of a calibration, and each change of signal will indicate a temperature change of one degree, if this is the temperature required to move the pointer from one of the comb's teeth to the next. In actual soundings the initial temperature at the ground is determined and then the sequence of the signals is followed. If the signals are received without a break nothing else is required to find out the vertical distribution of temperature. But uninterrupted reception cannot be had always, hence special contacts *q*, which allow absolute readings of temperature at certain intervals, have been provided. These may be seen in Fig. III.

These special contacts may be regarded as the teeth of a fifth comb, the spaces between which are twelve times the width of a tooth. Off and on, the pointer makes the contact with a tooth of this comb together with a tooth of one of the other combs. The comb *q* is directly connected to the *B*-battery, which produces a constant buzz of the transmitter during the period of contact of the pointer with one of the prongs of this comb. As shown in the figure the buzz first replaces a tooth of the comb n_3, then of n_2, then n_1, then n_4, then n_3 again. It completely blots out the original signal but can be easily recognized as a characteristic point (the temperature of which is to be found from calibration data) from the combination of the buzz itself and the preceding and following signals. If, therefore, during a sounding signal is lost, one has to wait for a contact after the reappearance of the signal. This gives an absolute reading of temperature.

For obtaining pressure readings the pointer of the barograph slides over a comb *k*, which is connected to a flat spring m_0, standing opposite to the disc p_0 in exactly the same manner as the temperature arrangement. The shape of p_0 is such that a dash signal is produced with each revolution of the shaft *cd*. This dash falls with the dot of the temperature measurement. Thus every time the barometer pointer contacts with a tooth of *k*, the transmitter will radiate, in Morse code, *t*, *n*, *d*, *b*, instead of *e*, *i*, *s*, *h*. A pressure calibration is required for finding out these points corresponding to the changes in signal.

(c) *Bureau's Radio Meteorograph.*—In this instrument the pen arm of a meteorological element slides over a cylinder, rotated once or more number of times per second by means of a clock work or a fan drive. The cylinder consists partly of metal and partly of some insulating substance in such a manner that a wide open V is formed. This metal V has its tip at the bottom and extends all along the circumference of the drum at its upper edge. Thus an inverted V of the insulating substance having its tip at the upper part of the drum is formed. This is used as switch in the trans mitter. The length of the contact determines the position of the pointer and hence the meteorological measurement. As the pointer travels from the lower edge of the cylinder to the upper one, lower and longer contacts are produced. The time length of the contact measures the meteorological element. But this requires that the clock should run at a constant speed. The use of expensive and unreliable clockworks has been avoided by gearing to the cylinder a switching arrangement. This mechanical switching arrangement has recently been much improved upon and a much greater accuracy has been attained. The accuracy claimed is one millimeter of mercury and 0.2°C at intervals of less than 100 meters height. This, however, to a great extent, depends on the rate of ascension of the balloon.

Variable Frequency Radio Meteorographs

(a) *Duckert's Radio Meteorograph.*—Duckert employs the variation of carrier frequency of the transmitter to measure temperature. His instruments enable us to obtain a continuous record of temperature having only occasional interruptions for pressure markings. Fig. IV gives one such instrument. The instrument consists of a short-wave transmitter, a variable condenser, moved by a bi-metallic thermometer, and a contact system. The whole transmitter is contained in a small evacuated glass tube, only the variable condenser and terminals for batteries and antenna remaining outside. This is done in order to check undesired frequency variations due to changes of pressure, temperature and humidity. But the heat radiation from the transmitter itself causes a change in the frequency and hence in later models, materials which are un-

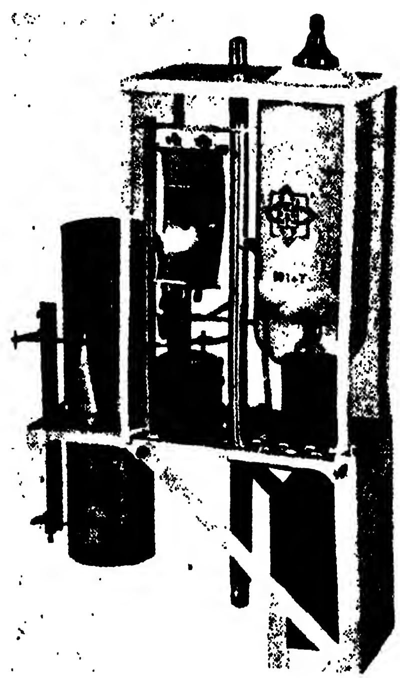

Fig. IV

affected by temperature changes have been made

The variable condenser is made up of two small brass plates, immersed in oil contained in a hard rubber vessel. A bi-metallic strip shielded from radiation by means of polished tubing steers one of the plates by means of an invar linkage. Thus the frequency of the transmitter is changed according to the position of thermometer. The pressure element moves a small gold plated wheel which revolves on another similar wheel. There are a number of insulated spots on the circumference of one of the wheels. During the passage of each of such spots the radio signal is interrupted. These points have to be calibrated beforehand, and air pressures corresponding to them predetermined. Between two such pressure points the rate of change of pressure, calculated theoretically from the

knowledge of the rate of ascent of the balloon is applied. The temperature signals are received with a short wave receiver having a frequency range equal to the total range of the transmitter. Dial readings are taken versus time and expressed in units of temperature. The pressure signals are also plotted on the same graph and intermediate readings are interpolated as explained above.

(*b*) *Vaisala's Radio Meteorographs.*—Vaisala's instrument is simple, light and inexpensive, and is shown in fig. V. Vaisala realized the difficulties in building a transmitter where all undesired changes of frequency are eliminated. So he found a simple way to take them into account. His transmitter also consists of a variable condenser, one of the plates of which is moved by a thermometer. But there are two more fixed condensers, the capacity of one of which equals the lowest capacity of the variable condenser while that of the other equals the highest capacity of the variable condenser. There is also another variable condenser moved by a barometer. A fan resembling a cup anemometer drives a switch which puts the four condensers successively into the transmitter circuit. Hence the received data show, firstly, the undesired frequency changes on both sides of the total frequency range, secondly, the frequency changes brought about by temperature from both desired and undesired causes, and lastly, the frequency changes caused by pressure from desired as well as undesirable causes. It is easy to see that these reduce the problem to a mere consideration of capacities instead of variations in frequency.

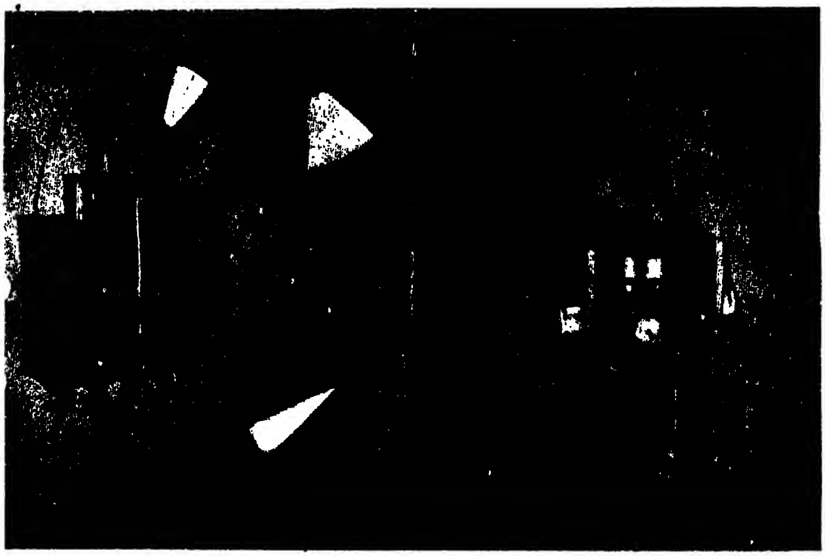

Fig. V

Development of Trunk Telephony in India

H. P. Bhaumik

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SINCE the beginning of the present century Telephony has become a most important branch of Electrical Communication Engineering. Its development has been phenomenal in Europe and America both for business and social purposes, and even in India we have seen its remarkable growth during recent years. The use of a telephone, consciously or unconsciously, creates a habit in the user, and when it has been used for a time, it becomes a necessity of life. This is known in common parlance as the telephone habit. The habit has grown to such an extent in Western countries, particularly in America, that it has there become a common appendage to a house. Whether for business purposes or for social amenities, the telephone has become an indispensable necessity. Further, Telepony has played and will continue to play a very important part in the material progress of a country and will always contribute to its commercial and industrial advancement. Here in India we are rather backward in our appreciation of the facilities offered by the use of a telephone. Considering the vastness of the country, our progress so far has been extremely slow. A good beginning has, however, been made, and concerted and well thought-out plans for the spread of telephone net-works over long stretches of this sub-continent have been the serious concern of the Indian Posts and Telegraphs Department for several years past. The results have been encouraging, and judging from the fact that the facilities for telephonic communication have been readily availed of wherever they have been provided, I am convinced that there is in India a bright and interesting future for this branch of electrical communication. Its continuous growth will, of course, depend on the commercial and industrial development of the country and a proper understanding of the advantages secured by its use in all spheres of life.

History of the Telephone Systems in India

Before describing specifically the development of Trunk Telephony in India, it will be interesting to give a short history of the growth of telephone system in general in this country. It will show how, from a crude beginning, we have arrived at the present state of development. We cannot do this better than by quoting from a Departmental Publication dealing with this subject: -

"It may be of interest to recall that the first private line supplied by the Telegraph Department was erected in August 1875 between the fort office of the Peninsular and Oriental Steam Navigation Company in Bombay and the Mazegaon Dock Yard. The modern Telephone had not then been invented and the instruments used were of the alphabetical dial type. Other firms and companies followed the lead of the Peninsular and Oriental Company and private lines worked with the "A", "B", "C" or alphabetical dial instruments soon became general in all large cities in India."

It will be readily seen that the private lines referred to above are not telephone circuits as understood by us now, they were really telegraph circuits worked visually with the well known "A" "B" "C" apparatus. These circuits were given to individual subscribers and they could be worked by the subscribers without any special training. They were thus the fore-runners of the telephone circuits which came in their wake.

The Report Proceeds:

"The invention of the Microphone in 1877 and the rapidity with which it was improved and combined with telephone gave a new direction to the attention of the Department. Various forms of apparatus obtained from England, America and elsewhere were put under trial, while experiments with other designs were made, an instrument designed by the Departmental Electrician was finally adopted."

The "A" "B" "C" instruments were replaced by telephones and the Department announced its

willingness to supply telephone lines and exchanges to the public. Since then the Government systems have steadily, though slowly, expanded. The Report further adds:—

"The Department has kept itself in touch with the latest improvements in apparatus and at all times has striven to supply a first rate service. In 1907 the first Central Battery Exchange in India was installed at Cawnpore, and in 1913, the first automatic exchange in the East was installed in Simla."

The history of the licensed telephone systems which are still operating in India is also interesting. As early as 1881, the Government of India decided to encourage private enterprise in telephone business and accordingly licenses were granted to the Oriental Telephone Co., to establish exchanges in Calcutta, Madras, Bombay and Rangoon, which they did. In 1882 the same Company was allowed to open an exchange at Karachi. In 1883 this Company was allowed to transfer its licenses for Bombay (including Karachi) and Calcutta to the Bombay and Bengal Telephone Companies, but it retained its licenses for Madras and Rangoon. The control of these two systems was subsequently transferred to local companies.

The royalty to be paid by the Company was originally fixed at 10 % of the receipt, but in 1883 this was reduced to 5 %, plus 1 % for all connections extending beyond the limits specified in the licenses. These rates are still in force. Though there was a proposal to purchase the Companies' undertakings in 1923 when their licenses were about to expire, the Government finally decided not to exercise its rights and the licenses were extended till 1943 under certain additional conditions to ensure the efficiency of service according to modern standards.

Automatic Exchange

The foregoing is a brief history of telephone development in India till about the year 1923. Further expansion and important developments have since taken place. Even several years prior to 1923, a large automatic exchange was installed at Lahore. Automatic telephone exchanges have now been installed in various other places such as Delhi and New Delhi, Cawnpore, Allahabad, Nagpur, Poona, Rawalpindi, the coal fields in Bengal and Behar, Ootacamund, Coonoor etc. A recent development has been the installation of small automatic excanges (20 to 50 lines) in many small towns of the Punjab, Central Provinces, Madras, Behar, Orissa and also a few in Bengal and Assam. These exchange switch boards are designed to serve small areas and if properly planned and organized, the installation of these boards in rural areas and in other out-of-the-way places will give a real impetus to the expansion of telephone facilities of the country.

Before the advent of Automatic Exchanges manually operated magneto and central battery exchanges were in operation all over the country. In automatic exchanges, the operators are eliminated, and subscribers once used to automatic exchanges do not like the use of magneto and C. B. exchanges. This is, of course, quite natural as the elimination of operators saves time and all troubles due to the idiosyncrasies of the human element. However, the manual telephone systems, specially the C. B. variety, cannot be entirely eliminated, and if properly maintained they give quite an efficient service. The modern tendency however is to replace all large manual exchanges by automatic exchanges. With the conditions at present prevalent in India, the manual C. B. systems will probably continue to be in service for some time to come, though the magneto variety will go out of use in no distant time.

The Long-distance Trunk Circuits

This account of the development of local exchange systems is necessary for a proper appreciation of the recent development of trunk telephone circuits in this country. The long-distance and trunk connections almost always follow the growth of the local exchanges. If there is rapid and extensive growth of the local systems, there will be correspondingly increased demand for the linkage of these local systems, which ultimately leads to the establishment of trunk connections and these, though of moderate lengths in the beginning, are followed by the provision of long-distance circuits extending over hundreds of miles in a vast country like India. This is strikingly demonstrated by the fact that the most important development in telephone communication which has recently taken place in India relates to long-distance telephony linking up the local exchanges installed in most of the important

cities in India. The technique of long-distance telephony is quite different from that of local exchange systems and calls for the solution of some very difficult problems which do not concern the local exchanges. India is a country of long-distances and the trunk telephone circuits between different cities situated widely apart consist of aerial wires carried on iron-poles. Due to the variations of climatic conditions in different parts of the country, the task of maintaining these aerial circuits in a suitable condition for the transmission of telephone speech is not an easy one. Yet in spite of these natural difficulties the Indian Posts and Telegraphs Department have succeeded in establishing a network of long-distance trunk telephone circuits in India during the last ten or twelve years which from the point of view of efficiency compares very favourably with similar networks in other parts of the world. Owing to the long distances involved, repeaters have to be installed in intermediate offices to strengthen the speech currents. These repeaters consist of thermionic valves which amplify the speech currents passing over the circuits. In modern telephone repeaters the emission of electrons from hot cathodes of thermionic valves, is made use of for amplifying the minute speech currents. This is a striking instance in which the result of research of theoretical physics has been practically employed in the development of long distance electrical communication.

The first important long distance trunk circuit with repeaters was introduced between Calcutta and Delhi. This was inaugurated in the year 1926. The distance covered being 900 miles. This circuit had at first two intermediate repeater stations, *viz.*, at Patna and Lucknow. Later on, to improve the transmission efficiency of the circuit, a third repeater was installed at Asansol. The next long-distance trunk circuit was established between Bombay and Delhi. The distance in this case also is about 900 miles. This circuit has three intermediate repeaters, *viz.*, at Agra, Rutlam and Surat. Gradually other long-distance trunk circuits, mostly worked on the carrier system (of which a description will be given later), were installed and we have now in India a fairly large network of telephone trunk circuits enabling one to carry on conversation from one end of the country to the other. For example, it is an easy matter now to carry on a telephonic conversation from Rameswaram to Peshawar and from Karachi to Shillong. The lonely outposts in the N. W. Frontier Provinces can now be placed in direct telephonic communication with all the important cities in India. One should not imagine that the speech on these trunk circuits is inferior to the speech on the local telephone circuits. On the contrary, the trunk speech is often better than the local speech. The distances over which conversation takes place on some of these trunk circuits are often several thousand miles. This is particularly the case when the direct route is interrupted and conversation takes place on a built-up circuit following a round-about route. For example, it sometimes happens that Calcutta cannot be connected to Simla over the direct route due to some line trouble. In that case the Calcutta subscriber talks to the Simla subscriber *via* Bombay. The distance between Calcutta and Bombay is 1250 miles, between Bombay and Delhi about 900 miles and between Delhi and Simla over 200 miles. So that the total length of the circuit over which conversation takes place works out to be nearly 2400 miles. A conversation from Rameswaram to Peshawar can take place on a circuit of which the length is still greater. It works out to nearly 4,000 miles when the conversation is carried on *via* Bombay and Calcutta. Such are the long circuits over which telephone conversation is now possible in India. It may again be mentioned that, in considering the efficiency of these circuits, we should not forget that they all consist of bare aerial wires subject to very wide variations of temperature and also liable to be affected simultaneously by different kinds of weather conditions over different sections of the same circuit. The extraneous noises are sometimes so great that speech is absolutely drowned by them. This is the most difficult problem in long-distance telephony which confronts the telephone engineers in India, and on its satisfactory solution depends the efficiency of long-distance telephone service in the country. A minimum difference between the speech and noise level on a telephone circuit must always be maintained for satisfactory performance of the circuit. It is a comparatively easy matter to transmit speech on a high level specially on a carrier telephone circuit, but we soon come to a limit beyond which this level cannot be raised due to other troubles such as noise,

interference with the performance of the circuits, etc., on the same route: Therefore the solution lies in trying to reduce the noise level rather than to increase the speech level. This is effected by separating the circuits as far as possible and by a system of altering their positions on the poles along the route. This latter process is known as the "Transposition of the circuits." It briefly means that the different circuits on the same line of posts are crossed over according to pre-arranged plans to nullify the effect of inductive disturbances on the circuits. The designing of transposition schemes for long-distance telephone circuits is not a simple matter and calls for special technical skill involving a knowledge of specialized mathematics and also a practical experience of local circumstances prevalent in the country. That satisfactory commercial speech has been practicable on long-distance trunk telephone circuits is no mean tribute to the superior construction of the aerial lines in the country. In Europe and America, long-distance trunk telephone circuits are often carried through underground cables. It is fairly easy to maintain such circuits in a stable condition and to reduce the inductive disturbances to a minimum. But the maintenance of aerial circuits in proper order under the Indian working conditions is a very difficult problem. The only countries where really long distance aerial circuits similar to those of India are in use are the United States of America, Canada, Australia and probably Russia. There too, the present tendency is to make greater use of underground cables wherever practicable and in a few years all these aerial circuits will probably be converted into underground cable circuits. It is however quite impossible to use such cables in India as the cost of laying thousands of miles of underground cables for telephonic communication is beyond the present financial resources of the Posts and Telegraphs Department.

The Carrier Current Working

The introduction of what is known as the carrier current system of working has enabled the Posts and Telegraphs Department to make further and somewhat rapid progress in developing long-distance telephonic communications. This has been the means of providing several telephone channels on one pair of wires between important centres. It has been found possible to sueprimpose telephone circuits on existing telegraph circuits after carrying out certain improvements to the lines. This has avoided the necessity of investing large sums of money in new line constructions, which is certainly a great advantage. In the carrier current telephone and telegraph working the thermionic valves play the most important part. The valves in carrier current working are used for a variety of purposes, *viz.*, for generating the oscillating carrier currents and for their modulation and demodulation by the speech currents. The valves are also used for the amplification of currents in various stages of the working process. The oscillating currents are generated in different groups of frequencies and are modulated by different speech currents. They are then transmitted over the same pair of wires. At the receiving end the different groups of these modulated oscillating currents are separated by devices known as electric filters which are combinations of condensers and coils. Each electric filter allows only one band of modulated oscillating current to pass through it. The different groups of modulated oscillating currents are then demodulated, *i.e.*, the telephone currents are separated from the oscillating carrier currents and are passed to separate telephone equipments at tht receiving end which are quite distinct from one another and afford means for independent telephone communications. The oscillating currents are called "Carrier Currents" as they, as it were, carry the telephone currents on the line wires and deliver them to separate ana independent telephone circuits at the receiving end. The channels do not interfere with one another. The same principle can be applied to the transmission of telegraph signals and a number of telegraph channels can be worked on the same pair of wires. Lastly, by suitably choosing the frequencies of the carrier currents, a number of telegraph and telephone channels can be worked on the same pair of wires, in addition to the ordinary telegraph and telephone channels. This is a very rough and meagre description of a highly technical and ingenious system of electric communcation which has been recently introduced in India. The first carrier telegraph system was introduced between Calcutta and Bombay in the year 1931, which made provision for 10 up and down carrier telegraph channels between the above places on the same pair of wires, only 4 up and down

channels being actually used so far. In 1934, three carrier telephone channels were added to the same pair of wires with the reseult that there have been provided four telephone circuits on which four people in Bombay and Calcutta can carry on telephonic conversation at the same time and on the same pair of wires without interfering with each other's speech; all the time these conversations are going on, the 4 up and down telegraph channels are utilized for passing telegraph messages without causing interference with one another and with the telephone channels. As already mentioned the distance between Calcutta and Bombay is 1,250 miles. There are carrier repeater stations at Jamshedpur, Jharsugnda, Raipur, Nagpur and Bhusawal for working the above carrier scheme. No other long-distance carrier circuit equipped with so many telegraph and telephone channels and working through five repeater stations on a single pair of aerial wires exists in the East. Even in Europe, such long multichannel carrier circuits equipped with so many repeater stations and worked on a pair of aerial wires has not so far been installed, controlled and maintained by a single administration. Other carrrier channels have also been installed between Calcutta and Delhi, Delhi and Bombay, Bombay and Poona, Poona and Madras, Bombay and Ahmedabad, Delhi and Lahore, and between some other places. All these circuits are equipped with the most up-to-date and efficient apparatus available anywhere in the world. Though, some of these are single channel carrier circuits, all are very likely to be converted into multichannel circuits in the near future to meet the expanding traffic demand. The Delhi-Lahore carrier circuit is already equipped with three telegraph and three telephone carrier channels. A new carrier circuit has been recently installed between Bombay and Delhi with three telephone and four telegraph channels. Another important carrier circuit is under contemplation between Bombay and Karachi *via* Ahmedabad. This circuit will be fitted with three telephone and four telegraph channels. The Calcutta-Delhi carrier circuit which is at present equipped with only one carrier telephone channel will in the near future be equipped with three telephone and four telegraph channels. As time passes on, the demand for addditional long-distance telephone facilities will grow very rapidly and already there are other proposals to extend this system of working on several long routes. The carrier system is peculiarly suited to the conditions in India. Owing to the long distances involved, it is impossible to erect a large number of wires for increasing the number of channels. With the application of the carrier principle the same pair of wires can be made to carry several telegraph and telephone channels. The advantage of further extending the use of carrier system is thus obvious, for though the equipments are fairly expensive, they are certainly cheaper than the cost of erecting new wires over very long stretches of the country.

International Telephonic Communication

Next to the adoption of the carrier system in India, another striking advance that has taken place recently in electrical communication is the provision of facilities for international telephonic communication. It is now possible from any telephone subscriber connected to the trunk telephone network in India to put himself into communication with almost all other telephone systems in the world. The channel of communication for such a trunk service is *via* the radio link which connects India with England by wireless. The land line is first connected to the Exchange at Kirkee (near Poona). From Kirkee the speech is passed on by short-wave wireless telephony to England whence it is extended to all other countries with which England is connected for telephonic communication either by land lines, cables or wireless. This service was opened in India on the 1st of May 1933, and since its inauguration the demand for overseas connections has been steadily growing.

We have however a separate arrangement for telephonic communication with Ceylon. The trunk service with Ceylon was opened about 3 years ago. The land line in India had been extended to Rameswaram. Between Rameswaram and Talaimannar on the Ceylon coast a special combined loaded telegraph and telephone cable was laid in March 1934. The laying of this cable which is the first of its kind in India, has made the establishment of communication with Colombo and other telephone centres of Ceylon, a simple matter. Lastly, through the enterprise of the Indian Posts

and Telegraphs Department, Burma has been linked up with the general telephone network of India. A short wave radio link service has been established between India and Burma. This terminal offices are Madras in India and Rangoon in Burma. This link is also very popular and has met a pressing need of the commercial communities of the two countries.

Need for Nationalizing Telephone System

An account of the development of trunk telephony in India will not be complete without a reference to the financial aspect of this development. It is very remarkable that while the number of telegrams as well as their values per annum has not shown any very marked rise during the last few years, the telephone revenue is steadily increasing. This is a clear indication that the convenience and facilities afforded by the telephone are gradually being more and more appreciated by the general public. The trunk telephone revenue has risen from about 5½ lakhs in 1925-26 to nearly 32 lakhs in 1936-37. Similarly the income from local telephone connections has increased from about 26½ lakhs in 1925-26 to over 46 lakhs of rupees in 1936-37. Further growth of income under both these heads is sure to follow in the future. In this connection it will not be out of place to mention that the largest local telephone systems of the country, namely, those in Calcutta, Bombay, Madras and some other places are worked by private companies. The royalty paid by all these companies in 1936-37 was about 4½ lakhs of rupees, whereas the revenue earned by them was more than 94½ lakhs. Again, of the total number of local telephone connections of nearly 73,146 (excluding those of Burma) in 1936-37, as many as 42,245 were supplied by the licensed companies and 30,901 were only supplied from the Government systems. It should be remembered that the licensed systems operate in the 3 or 4 most populous centres whereas the Government systems are scattered over numerous comparatively small cities and still smaller provincial towns some of which are no better than glorified villages. The effect of this distribution is that while the licensed companies operating in compact areas can manage their systems very economically, the scattered Government systems naturally cost more in first installation as well as in maintenance charges. Government have to embark on very expensive trunk development schemes without the benefit of substantial financial assistance from the lucrative local systems operating in the large cities such as Bombay and Calcutta. This anomalous arrangement should be done away with as soon as possible, and both the long-distance and the local telephone systems should be brought under the control of one administration. In consideration of the importance of electrical communication as a Public utility service, I am of opinion that for better co-ordination and more extensive development both the long distance and the local telephone systems should be owned and managed by the State. This was realized by the British Post Office many years ago and the result was the nationalization of the telephone systems of Great Britain which are now owned and managed by the British Post Office to the great advantage of that country.

It will be of interest to mention here the sources of supplies of equipments required for long distance as well as local telephone systems. As far as the long-distance equipments are concerned, the supplies so far are being obtained from outside India. There are only three or four firms in Europe and America who are pioneers in the manufacture of long distance communication equipments and the Indian Posts and Telegraphs Department have to take advantage of the experience and practical knowledge of technical details of these firms for the design and installation of equipments to suit the special requirements of this country. As regards the local telephone systems substantial progress has been made in the manufacture of equipments in this country, and the Telegraph Workshops at Alipore have played a very important part in this direction. Consideration of space does not permit us to go into details of the activities of the Telegraph Workshop but it will suffice to say that almost all the requirements of the Department for C. B. and magneto telephone exchange switch boards and their fittings are being satisfactorily manufactured in these shops.

Need for a Research Branch

Another great desideratum is the organization of a research branch in India to study the problems

of Electrical Communication in general and of long-distance telephony in particular. Numerous problems arise which cannot be satisfactorily solved by agencies operating in other countries as the conditions are not identical. Indeed, manufacturing companies had to depute special staff to this country in the past to study the problems on the spot before undertaking the manufacture of apparatus required by the Posts and Telegraphs Department.

There is also a need for further increase of the number of trunk circuits connecting important trade centres. According to modern practice, one circuit should be provided between two centres for every thirty trunk calls per day. For a really first class trunk service it is very essential to approach this standard as closely as possible. The popularity of the trunk service will depend on the rapidity with which connections can be given. There will be a great increase in the revenue as soon as a quick and reliable service can be ensured. The creation of confidence in this respect in the mind of the public is very essential for the growth of revenue. Unfortunately want of proper financial resources stood in the way of the rapidity of development. It is however understood that greater attention is being paid to this aspect of the development of long distance telephony and a rather ambitious programme is being arranged for the next five years.

Telephone Habit Growing

I may mention once more how the telephone habit of the people of this country is growing. Nowhere is this more apparent than among the Indian commercial communities, particularly in the Punjab and in Bombay, while in Madras, where the facilities for telephonic communication have been extended long after those in the Punjab, the people are rapidly coming to the fore-front in making use of them. There is so much zeal, eagerness and rivalry among the merchants and trades people in making use of the facilities to improve their business interests, that many subterfuges are resorted to by subscribers in busy centres of trade to secure priority of service in making trunk-calls, and sometimes the Posts and Telegraphs Department are hard put to it to counteract the dubious methods adopted by them. This trouble is a direct result of a paucity of trunk circuits between the various trade centres. In the bazaas at Amritsar and Ludhiana, the trades people are busy with their telephones the whole day. The same is true of merchants and tradespeople of Surat and Ahmedabad and other busy trade centres. There are many other places where this brisk and continuous use of telephone is going on from morning to evening. There is always a great demand for new connections once a telephone system is installed. The demand increases still further when the system is brought on to the trunk network of the country. The use of the telephone for social purposes is not yet very extensive, but it is bound to come at no distant date. Again the development of telephone communication and particularly trunk telephony is closely linked up with the growth of industries. As a matter of fact in this case, one helps the other. It is a matter for regret that Bengal has not yet taken full advantage of the facilities offered by long distance telephonic communication. The tea and jute industries of Bengal ought to have given scope for the installation of many telephone systems and their interlinking trunk circuits. However now that Dacca, Darjeeling and Shillong have been linked with Calcutta, it is hoped that there will be substantial development in this direction in the districts of Eastern and Northern Bengal and Assam.

Conclusion

In conclusion it is significant to note that according to the available statistics there is roughly one telephone for every 5,000 people in India, whereas in America there is one telephone for every six or seven persons. This shows how backward the country is in respect of the development of Electrical Communication. We need not however be discouraged by these figures. Judging from the development that has taken place in the very short period of the last 10 or 12 years, I am inclined to think that in the next decade with favourable trade conditions further expansion, both in local and long distance telephonic communication, will take place. The rates for telephone connections have now been reduced by the Government, and I have no doubt, with larger expansions of the telephone systems, further favourable terms are likely to be available for local as well as trunk circuits. It is understood

that Government have aready taken steps to set up a special organization for the study of the growth and distribution of telephone traffic and to work out equitable rates on economic basis both for local and trunk telephones. This is certainly a move in the right direction and will, it is hoped, help in popularizing the use of telephone and ensure its further expansion.

There are untold resources in the country which are awaiting development. In modern times the development of Electrical Communication is closely linked up with the growth and development of industries. As time progresses, there will be greater and greater demand for telephone facilities in India. In spite of the comparatively rapid development during the last few years of long-distance telephone circuits, we are just on the threshold of an era of prosperity in this respect, and this prosperity will, let us hope, continue and India will increase its facilities for electrical communication at least ten times in as many years.*

* Based on an address delivered by the author before the Calcutta Rotary Club on May 24, 1938.

Separation of Isotopes

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The separation of isotopes, that is, atoms of different mass occupying the same place in the Periodic Table, is a difficult problem; in fact, it is this inseparability which led to their original discovery. Boltwood in 1906 noticed that if by chance thorium and ionium compounds became mixed it was impossible to separate them by any chemical means. Similar identities were found among other products of radio-activity and this led Soddy to publish in 1910 his theory that the same chemical element could have atoms of different weights which he subsequently called 'Isotopes'.

The first partial separation of the isotopes of neon I achieved by diffusion through pipeclay. The possibility of this rests on the fact that the rates of diffusion of atoms in a gas are inversely proportional to the square roots of their masses. As even in the favourable case of neon atoms of masses 20 and 22 respectively the 21st root is involved, the method is extremely laborious, but after many months of work I was able to show a change in density of 0.7 per cent with a possible error of 0.1 per cent. This result I announced at the British Association meeting at Birmingham in 1913, the same meeting at which Soddy gave his amplified theory of isotopes in radio active disintegration. I remember, years later, in 1920 when the isotopic nature of chlorine had been fully demonstrated by means of the mass-spectograph, talking with Sir W. Pope, who was of the opinion that we should have tons of chlorine 35 and chlorine 37 separated in a year or two. My own experience enabled me to assure him that this was by no means the case, and that the separation of isotopes was too difficult for it to affect the ordinary work of the chemist for many years to come, a conclusion which subsequent events have fully justified.

Diffusion through porous media was used by Harkins in his pioneer experiments on HCl vapour. He worked on a large scale and in 1920 was able to show that a small change in the atomic weight of chlorine had been obtained. Brönsted and Hevesy

obtained partial separation of the isotopes of mercury by the elegant method of slow distillation in a vacuum so perfect that none of the evaporating atoms could return to the surface of the liquid. Under these conditions the lighter isotopes escape more freely than the heavier ones and it was found that the increase of density in the residue, though exceedingly small, was exactly in agreement with theory.

Separation should be possible by the action of gravity and Lindemann has suggested that the neon in a sample of air from the upper part of the stratosphere should be lighter than normal neon. This experiment has not yet been carried out. Many attempts have been made to apply the high gravitational field available in centrifuges to the problem but with no success. This failure is generally attributed to the impossibility of eliminating vibration. Research in this method is still going on in Oxford and other places by the use of the modern ultra-centrifuges. If the technical difficulties can be overcome this is probably the most promising method of general application for separation on a practical scale. Ionic migration in gelatine under electric fields was tried by Kendall but though this method separated substances as similar as two of the rare earths from each other, no success was obtained with isotopes. A very beautiful photochemical method is that of allowing light of very restricted wave-length to fall on $COCl_2$ vapour. If the wave-length is chosen correctly the lighter isotope of chlorine will be dissociated preferentially. This method has given positive results but the change in atomic weight and the quantities obtained are very small.

To turn to more recent successful work remarkable results with neon have been obtained by Herz who devoted many years to the problem. By means of an ingenious system requiring the simultaneous working of 48 mercury diffusion pumps he is able to obtain either the light or the heavy isotope in small quantities up to 99 per cent purity. This is a technical triumph of a high order but unfortunately not only is the apparatus extremely difficult to work but it only seems to function properly with the inert gases, which are of little interest to chemists.

Another method giving perfect separation is by using a mass-spectrograph to resolve beams of the isotopes and collecting these on targets cooled with liquid air. The difficulty here is to obtain beams of sufficient intensity to produce an appreciable yield in a reasonable time. This was done in the Cavendish Laboratory in the case of the isotopes of lithium 6 and 7. Pure specimens of these bodies were prepared and, although only containing micrograms, were sufficient for use in the transmutation apparatus of Lord Rutherford and his colleagues, who were able to investigate the reactions of each isotope separately, and so solve the problems involved in the artificial distintegration of the element lithium. Mass-spectrum separation has also been applied with success to the element potassium in America, and at the present time every effort is being made to use it to obtain pure specimens of the isotopes of boron 10 and 11, but so far without success.

The most remarkable case of separation on a chemical scale is the unique one of the isotopes of hydrogen 1 and 2. The latter is only present to the extent of about 1 in 5000 but the difference in mass is so large that separation can be obtained without serious difficulty by electrolysis. Heavy hydrogen is therefore of such importance in chemistry that it has been named Deuterium by Urey, its discoverer, and has been given a separate symbol D. Pure heavy water D_2O is made in large quantities at hydro-electric works in Scandinavia and elsewhere at a moderate cost. Further electrolysis of heavy water should result in a concentration of the still heavier isotope of mass 3, which is certainly formed in some nuclear transformations, but direct analysis by the mass-spectrograph of the concentrates from very large volumes of heavy water has shown that this isotope does not exist to any appreciable extent in normal hydrogen.

A few months ago it was reported that Urey had succeeded in a partial separation of the isotopes of nitrogen 14 and 15 by a differential diffusion of ammonia in a very long absorption tower. This result is of particular importance, for the preparation of heavy nitrogen, even if impure, would open up a new and interesting field in biochemistry as the movements of this element could then be traced in the metabolism of living organisms.*

* Substance of an address delivered at the Indian Association for the Cultivation of Science on January 6, 1938.

The Physics of the Atomic Nucleus in the USSR

L. A. Arzymovich

[The following article by L. A. Arzymovich on the "Physics of the Atomic Nucleus in the USSR" is the third of the series devoted to describing the progress of physics during the last twenty years in the Soviet Union, reproduced from the "Physikalische Zeitschrift der Sowjetunion," 12 pp. 527-541, 1937, published on the occasion of the Twentieth Anniversary of the Great October Revolution of 1917. The first two of the series "Twenty Years of Soviet Physics" by A. F. Joffé and "Twenty Years of Soviet Optics" by A. M. Tschulanovsky were reproduced, it may be remembered, in our May and June issues respectively.

Ed., Sc. & Cul.]

THE study of the structure of the atomic nucleus is a new but rapidly developing branch of physics.

In the USSR this development is proceeding at a particularly high speed owing to the exceptionally favourable conditions created for science by the Communist party and the Soviet Government.

In pre Revolutionary Russia nuclear physics was not studied. Although the problem of radioactivity, out of which modern nuclear physics has grown, had already acquired great importance at the beginning of the twentieth century and radioactivity research was making great progress, especially in France and England, no systematic work in this field was done in Russia.

The cause was the general weakness of Russian physics, lack of scientific workers and especially lack of funds for scientific work, the organization of laboratories and the acquisition of expensive radioactive preparations. During the first years which followed the October Revolution, years of intense growth of Soviet physics, the attention of the majority of physicists abroad and in this country was concentrated on questions of molecular atomic physics. The extraordinary progress in the study of atomic structure and electronic physics, the application of new atomic models to investigating the structure of solids, the solving of the mystery of the chemical bond, all achieved in the course of these years, caused the problems of the atomic nucleus to sink into the background for a time. However, in the same period which ended about 1931-32 new laboratories were organized in the USSR which are devoted to nuclear physics.

Among the Soviet work accomplished during this period the first to be named are the fundamental papers of D. V. Skobeltzyn.

In 1925 Skobeltzyn on the initiative of A. F. Joffé created a strong magnetic field in a cloud chamber in order to determine the energy of fast electrons from the curvature of their tracks. This method, first used by Skobeltzyn, is now widely employed and became one of the basic methods for the investigation of fast particles. It permits us to study the energy spectra of the rays emitted by radioactive substances, to analyse the composition of the cosmic radiation, to measure the energy balance of the different interaction processes of fast electrons with matter, etc.

In 1927-1929 Skobeltzyn carried out with the help of this method his classical investigations of the Compton scattering of hard γ-rays. In these works the mechanism of the elementary act in the scattering of γ-photons was first studied at length and the conclusions of the relativistic quantum theory quantitatively checked. The method of magnetic analysis enabled him also to measure the composition of the γ-spectrum of Ra(B+C) and ThC″.

Skobeltzyn was the first to notice traces of cosmic radiation in the cloud chamber and to prove that these were particles of enormous energy (above 10 million volts). All these works were done in the

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small laboratory created by Skobeltzyn in the Leningrad Physico-technical Institute.

In 1923 the State Radium Institute was founded in Leningrad under the superintendence of the People's Commissariat for Education of the RSFSR. This institute became one of the most prominent centres of radioactivity research in the USSR. The Government put at its disposal 1 gram of radium for research and practical (medical) purposes.

Along with chemistry of radioactive elements and the problems associated with radioactive ores, the physical aspects of radioactivity are studied in the State Radium Institute and a systematic investigation of the cosmic rays absorption law is carried on.

Careful measurements of the absorption of cosmic rays in different substances were effectuated in the State Radium Institute in 1929 by L. V. Myssovski. This investigation was continued by Verigo and Vernov. Further, while studying the absorption of α-particles in photosensitive films, L. V. Myssovski discovered and worked out a new method of registering and observing the paths of individual α-particles, by the traces they leave in the layer they travel in.

The years 1932-1933 marked an upheaval in the development of nuclear physics. The artificial splitting of the nuclei of light elements by protons was quickly followed by the discoveries of new elementary particles, the positron and the neutron. The leading role of the nuclear problem is established by prominent physicists all over the world.

In England and the U. S. A. new methods of studying the nucleus were being elaborated, powerful high-voltage generators for the production of intense streams of fast particles were being constructed. Research in the field of the atomic nucleus received an entirely new technical base.

In the USSR several new centres of atomic nuclear research arose at this time and the activity in this field continues to develop on an entirely different scale.

Isolated activities of a group of two or three research workers are replaced by laboratories richly equipped with the new technique and a concentrated effort of large bodies of scientific workers solving the cardinal problems of nuclear physics. Particular attention was paid from the outset to the creation of a strong technical base so as to ensure a rapid development of nuclear research in the USSR during the next ten years.

In 1930 the Ukrainian Physico-technical Institute was organized at Kharkov, which during the years 1931-1932 launched the study of the atomic nucleus as one of the main directions in its work. To this purpose the Ukrainian Physico-technical Institute in 1932 proceeded to construct high-tension generators and tubes. After trying different types of generators the nuclear group of the Ukrainian Institute finally chose the Van-Graaff generator. After much work the Kharkov physicists succeeded in constructing a generator with the maximum potential of 4 million volts and a 12-meter tube fed from the Van-Graaff generator for producing a bundle of fast electrons.

The funds for the erection of the new building for the high-voltage laboratories of the Ukrainian Physico-technical Institute and for the construction of the generator were supplied by the People's Commissariat for Heavy Industry on which the Institute is dependent. In constructing the generator valuable help was received from the great Kharkov factories. By the end of 1936 the generator was ready and the tube made and tested in 1937. At present the tube connected with the generator can give electrons with energies up to 2 million volts, the current being of the order of ten microamperes.

In 1933 the Leningrad Physico-technical Institute of the People's Commissariat for Heavy Industry joined in the work on the atomic nucleus.

In the Leningrad Institute several nuclear laboratories were formed simultaneously. At the same time nuclear research began to develop at the Physical Institute of the Leningrad University. Next to this nuclear laboratories were organized in the Physical Institute of the All-Union Academy of Sciences. The nuclear subjects in the Tomsk Physico-technical Institute date from as far back as 1931-1932. About 1934 the organizational structure and the disposition of the forces in Soviet nuclear physics was on the whole completed. Four great scientific bodies, the Leningrad Physico-technical Institute, the Ukrainian Physico-technical

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Institute, the State Radium Institute and the Physical Institute of the Academy of Sciences constitute the organizational basis of Soviet nuclear physics with more than 80 scientific workers engaged in the study of the atomic nucleus. These institutes, especially the first two, are seats of very intense and rapidly developing research. The problems treated in the USSR embrace nearly all the domains of nuclear physics. Intensive work is carried on for creating new sources of fast particles. We have already mentioned the construction of the electrostatic generator in the Ukrainian Physico-technical Institute. Not less important is the work done for the construction of Soviet cyclotrones (generators of the Lawrence type). The construction of one cyclotrone was begun in 1934 at the State Radium Institute, but it went slowly and up to the present the cyclotrone has not yet been brought to its full power. A design of a new powerful cyclotrone, which will give a beam of deuterons with energies up to 8 million volts, is now being elaborated in the Leningrad Physico-technical Institute.

In the last years the Ukrainian Physico-technical Institute and the Physical Institute of the Academy of Sciences received from the Government 1 gr. of radium each for research work. Thus nuclear physics of the USSR possesses now, as a basis for further progress, a splendid "atomic artillery" in Kharkov and 3 gr. of radium for research work. The construction of the big cyclotrone in the Leningrad Physico-technical Institute and the completion of the cyclotrone in the State Radium Institute will greatly reinforce the technical outfit of Soviet nuclear physics.

During the last four or five years the experimental work on the atomic nucleus in USSR developed along the following lines:—

1. Formation and destruction of pairs.
2. Study of continuous β-spectrum.
3. Interaction of fast electrons with matter.
4. Artificial radioactivity and interaction of slow neutrons with nuclei.

Of these four basic subjects the first two have been treated at the Leningrad Physico-technical Institute.

The properties of slow neutrons were studied by the Leningrad Physico-technical Institute and the Ukrainian Physico-technical Institute. A great many of the investigations in this field are products of the collaboration of physicists of the two institutes.

The properties of swift electrons were studied in the laboratories of Skobeltzyn and Alichanow in the Leningrad Physico-technical Institute, Lukirsky's laboratory at the Leningrad State University and the nuclear laboratories of the Physical Institute of the Academy of Sciences.

All the above mentioned subjects are of importance and will be maintained for the next years.

Passing now to review the work on the atomic nucleus accomplished by Soviet physicists we shall mention but the most valuable of them.

The most valuable among the investigations carried out within the period in question are the works of the laboratory of A. I. Alichanow in the Leningrad Physico-technical Institute devoted to studying the formation of pairs and the problem of the continuous β-spectrum.

In 1933 A. I. Alichanow and M. S. Kozodaev worked out a new method for analysing the energy spectra of electrons and positrons. In Alichanow's apparatus, electrons (or positrons) of a certain energy focussed by a transverse magnetic field are registered by a coincidence method when passing through two Geiger counters.

This method allows us to enhance a hundredfold the sharpness of each effect under examination, as against the background, since the counters register only the rays which travel through both counters in a given direction, whereas the effect of the by-electrons, produced by the action of γ-rays, is practically zero. This procedure was first devised by Alichanow for the investigation of pair formation processes. In these phenomena the effect is so weak that to study the energy distribution of the positrons produced by γ-rays with one counter is practically impossible. The method of coincidences enabled Alichanow and Kozodaev to carry out in 1934 an extensive study of the energy distribution of the positrons which arise from the interaction of γ-rays

of Ra(C+C′) and ThC″ with the field of the atomic nuclei of different elements.

The formation of positrons in substances of large (Pb) and small (Al) atomic number was investigated.

The results obtained by Alichanow and Kozodaev fully corroborate the conclusions of Dirac's theory of positrons.

While studying the formation of positrons under the absorption (internal conversion) of γ-rays, Alichanow and Kozodaev attempted to ascertain whether the positrons could be emitted directly by the radioactive source itself.

While studying the sign of the particles emitted in a radioactive disintegration by the sources Ra(C+C′) and ThC″ they found out that the two sources emitted positrons as well as electrons. To explain this phenomenon, Alichanow supposed that alongside of the internal conversion of the γ rays in the electronic shells of the atom, internal conversion of γ rays involving the formation of pairs can also take place. Alichanow and Kozodaev determined experimentally the output co-efficient of this conversion for the fundamental lines of the γ-spectrum of ThC″ and Ra(C+C′). The hypothesis proposed by Alichanow and the data of his measurements furnished the basis for the theory of Holm and Jäger, who showed that the effect discovered by Alichanow could be derived from Dirac's theory of the positron and was ... perfect qu.. .... qua agreement therewith.

method of coincidences was used Alichanow's laboratory for studying the γ-spectrum of natural radioactive sources by the β-lines produced as a result of conversion. These investigations led to the discovery of new lines in the spectrum of Ra (C+C′). In this year the laboratory has performed very interesting experiments concerning the angles of divergence of positrons and electrons arising through the internal and external conversion of hard γ-rays (source Po+Be). These measurements form a sequel to the measurements of the energy spectra of positrons.

One sees that the problem of pair formation has been treated to its full extent in Alichanow's laboratory. In studying the continuous β-spectrum, Alichanow, Alichanian and their co-workers obtained results of no less importance. From 1935 onwards the positron and electron spectra of the various radioactive elements have been studied systematically; the limits and the appearance of the spectra of 14 elements have been determined. A general law has been established for the change in the shape of the spectral curves in passing from lesser to greater atomic numbers. Alichanow's laboratory was very successful in investigating the distribution in the RaE spectrum. As a result of very fine measurements of the distribution at low electron energies Alichanow and Alichanian were able to prove that the shape of the distribution curve for the "classical" continuous RaE spectrum, heretofore regarded as firmly established, did not actually occur.

These measurements displayed the brilliant experimental technique which is characteristic of this laboratory. The importance of the measurements of the RaE spectrum in the region of small energies consists foremost in that they permit the changes in the spectral curve to be established on passing from small to large Z (atomic number) and the conclusion of Fermi's theory of β-disintegration to be checked.

Recently Alichanow, Alichanian and Dzelepow succeeded in making another advance in the study of the β spectrum. Having carefully measured the shape of the distribution curve of RaE near the limit of the spectrum, they showed that the curve [illegible] from zero. This suggests the possibility of estimating approximately the mass of the neutrino. The importance of this fact is evident; it suffices to say that so far no other method can provide any information whatever on this elusive particle.

The results of the investigation of pairs and β spectra won a well-deserved reputation for the group of Soviet physicists working under the guidance of A. I. Alichanow.

The verification of the conservation laws of energy and momentum during the annihilation of pairs carried out in 1936 by Alichanow, Alichanian and the writer, stands somewhat apart from the rest of the investigations on positrons. The pur-

pose of this work was to check the laws of conservation of energy and momentum in the elementary acts of interaction of material particles (as is known, the question arose in connection with the negative results of Shankland's experiments).

The validity of the conservation laws was completely confirmed by this work. It was furthermore shown that annihilation occurs chiefly at positron energies below 100 volts.

Among the other works on positrons the experiments of Skobeltzyn and Stepanowa (Leningrad Physico-technical Institute) are noteworthy. These dealt with the formation of pairs in the interaction of swift electrons with nuclei. Skobeltzyn and Stepanowa observed the escape of a large number of positrons from a plate placed in a cloud-chamber in the path of swift β-particles. The results of these experiments gave rise to an animated discussion, which is not yet closed. Skobeltzyn was one of the first to observe the traces of electrons and the formation of pairs in the gas of the cloud-chamber.

Among the papers devoted to the interaction of swift electrons with matter the most important are those accomplished in Skobeltzyn's laboratory at the Leningrad Physico-technical Institute, which are a continuation of the series of investigations performed by Skobeltzyn in the course of the years 1926-29.

In 1936-37 the collaborator of this laboratory, E. G. Stepanowa studied the scattering of swift electrons in nitrogen and argon. The analysis of the data showed that the number of scattering at large angles (above 20°) greatly exceeded the number given by Mott's theoretical formula. For angles of scattering above 90° the experiment shows the number of acts of scattering to be more than ten times the theoretical value (for scattering measured in nitrogen)

The divergence from theory is particularly striking in the scattering of electrons with energies exceeding 1.5 million volts. But it remains fairly large for comparatively slow electrons with an average energy of some 300 kV. It is interesting that the experimental data on argon (larger Z) are in better agreement with theory than those concerning nitrogen (lesser Z). According to Skobeltzyn these facts can be accounted for only by the superposition of two phenomena, the classical scattering obeying Mott's formula and some supplementary (intranuclear) scattering of an unknown species. This supplementary scattering must be less markedly dependent on the energy of the electron and the angle of scattering than the classical effect. A careful study of the same series of stereophotos brought out a large number of cases of abrupt loss of velocity and even stoppage of fast electrons in gases. The number of these cases turned out to be so large that the existing theory could not provide an adequate explanation of them. The assumption of a radiation mechanism of this retardation leads to values of the effective cross-sections much below those observed experimentally. Of course, the data obtained by Skobeltzyn and Stepanowa will have to be checked. Among the work in the same line the diffraction of fast electrons (with energies up to 500 kV) observed in 1932 at the Physical Institute of the Leningrad University by Alichanian and Kosman is of interest.

The investigation of neutrons and artificial radioactivity was first taken up in the USSR by I. W. Kurtschatow in the Leningrad Physico-technical Institute. Kurtschatow and his co workers have studied a large number of cases of artificial radioactivity arising through neutron bombardment and measured the disintegration constants of several artificial radioelements. The most important result obtained in Kurtschatow's laboratory is the discovery of so-called nuclear isomerism. This phenomenon was first discovered by Kurtschatow and Rusinov in 1935 in investigating the artificial radioactivity of bromine. It is known that bromine has only two stable isotopes with the atomic weights 79 and 81. But it has three distinctly differing disintegration periods. Control experiments showed that all these three periods can correspond only to nautron capture. Hence it follows that either the nucleus of one of the two initial stable isotopes can exist in two different stable states or, after the neutron has adhered to one of these nuclei, two different configurations may arise (*e.g.*, the neutron may be captured on the ground level or on the metastable level). Later in

studying radioactivity Kurtschatow and Selinow found that isomerism was not confined to bromine, but occurred in other elements as well.

A great amount of the work of Kurtschatow's laboratory is devoted to the investigation of the absorption laws and the scattering of slow neutrons.

Kurtschatow measured the effective cross-sections for the scattering of slow neutrons in different substances (iron, copper, lead, carbon, water). After Fermi's discovery of the groups of slow neutrons, Kurtschatow carried out a series of investigations of the absorption of these groups for silver, iodine, radium and other elements. Among the other works of this laboratory the investigation of the splitting of lithium and boron by slow neutrons by the cloud-chamber method deserves mention and the study of the mechanism of the splitting of lithium by swift protons. The results of these investigations have largely contributed to establish correct views on the mechanism and the energy balance of these nuclear reactions. Among other Leningrad Physico-technical Institute papers concerning slow protons and nuclear reactions during the last years we shall mention that on the absorption of slow neutrons by hydrogen. In this paper published by the writer in collaboration with Latyshev, Kurtschatow and Chramow it was clearly shown that the probability of the capture of slow neutrons was very large. This result showed that the theory of the deuteron as given by Bethe and Peierls was incorrect and needed radical remodeling. This work also gave an explanation of the apparent contradiction between the experiments of Chadwick and Goldhaber on photoneutrons and those of Lee on the absorption by substances containing hydrogen.

In the last years the Kharkov physicists also took up the study of slow neutrons. The presence of a hydrogen liquefier enabled them to conduct a series of very interesting experiments concerning the temperature dependence of neutron scattering at low temperatures.

The investigations of the last year carried out conjointly by the workers of the Ukrainian Physico-technical Institute and Kurtschatow and Rusinov permitted them to establish some very interesting new facts. Thus, for instance, after showing that the effective cross-section for the capture of thermal neutrons by substances such as boron and silver is inversely proportional to the velocity of the neutron at high temperatures, Leipunsky and his co-workers observed deviations from this law at low temperatures. Leipunsky and his co-workers observed deviations from this law at low temperatures. Apparently these deviations are due to some other factors, such as for instance the peculiar character of the interaction between very slow neutrons and the lattice.

A number of investigations of the scattering and the absorption of photoneutrons have been carried out at the Ukrainian Physico-technical Institute by Leipunsky and his co-workers. These investigations permitted them to carry out a quantitative verification of the theory of interaction between neutrons and nuclei based on the concept of the exchange nature of the nuclear forces.

Slow neutrons have also been studied since 1935 in the laboratory of P. I. Lukirski (Leningrad State University).

In 1935-36 Lukirski and Tsareva studied in detail the conditions under which the temperature effect may become manifest. They showed that a necessary condition for the manifestation of the effect was the correct choice of the thickness of the cooled transition layer in which the neutrons are slowed down by the effect of low temperature.

The results obtained from the work supplied one of the most convincing arguments in favour of the assumption that the capture of slow neutrons by protons has a high probability. In investigating the dependence of the temperature effect (the alteration of the neutron activity with the decrease of temperature) on the thickness of the transition layer, Lukirski and Tsareva found that the dependence was not the same for different elements. Hence one may infer that the resonance groups of slow neutrons partially lie in the region of thermal energies.

Summing up the achievement of Soviet nuclear physics on the twentieth anniversary of the October Revolution we see that they are very important.

In the solution of a number of the most import-

ant problems of the atomic nucleus Soviet physicists hold a prominent place.

However, on the whole our nuclear physics is still behind the leading capitalist countries, England and the U. S. A. This is due partly to the delays in bringing into service the high voltage generators and finishing the Lawrence generators.

Our main task at present is to obviate these obstacles and to pass on to new, more perfect methods of research.

The subjects of nuclear research now treated in the Union will probably not lose their actuality in the course of the next few years.

The principal directions will be as formerly the study of the properties of slow neutrons and hard γ-rays and the study of the interaction forces between neutrons and matter. But a transition must be made from studying the electrons and γ-rays with energies of the order of 1·2 million volts to energies of 5-10 million volts and upwards.

The investigation of slow neutrons will gain a new impetus from the construction of the Lawrence generator. It will render possible the transition from the study of integral phenomena to a close analysis of the scattering and the capture of slow neutrons of a certain definite energy. Accurate measurements of the energy balance of nuclear reactions will be possible after we have become familiar with the new method of precise mass-spectrography, which the Soviet physicists are now beginning to work at.

Every condition is now given for the most important branch of exact natural science, the physics of the atomic nucleus, to attain in the USSR such heights as are in keeping with the flourishing economical and cultural state of our great socialist country.

Test New Corn Seedlings With Artificial Drought

Corn farmers in the Great plains area frequently are confronted in mid summer with days, or even weeks, of high temperatures with low humidity and deficient soil moisture. Under such conditions it is necessary in any corn improvement programme to know the tolerance of any new strain to drought and high temperatures. Wide variations in weather from year to year make testing of this tolerance under field conditions uncertain. Unfavourable weather ideal for testing any new strain may not occur in any year or even in a succession of years. Specialists of Kansas State College devised a simple heat chamber with thermostatically controlled heat for testing the resistance of plants to heat. A small fan keeps the air in motion and insures uniform temperatures. Corn specialists of the Kansas station and the United States Department of Agriculture placed 14-day-old seedlings in clay pots in the chamber at a temperature of 140°F. and a relative humidity of about 30 per cent. These seedlings showed a great difference in resistance to drought conditions. Some strains withstood the heat for several hours and when returned to normal growing conditions recovered 100 percent. Others failed to recover. These same corn strains reacted almost identically in field plots in a drought year, showing the accuracy of the tests in the artificial drought chamber.

—*Journ. Frank. Inst.*

The Industrial Welfare Movement in Great Britain

B. B. Bhowmik

Within the last twenty years, a great advance has been made in Great Britain, not only in the material side of production but also in the welfare of the human beings employed in industry. In this movement, the Industrial Welfare Society has played a quiet, but effective part. Before the War, a few pioneers, such as the Rowntrees and the Cadburys had shown the way, but welfare work was generally regarded as the fad of a few philanthropists, and the general impression was that the result of such work would be to pamper the workers. During the War, vast numbers of women and young people never previously employed in industries, were taken into the munition factories. Sanitary and health conditions were quite inadequate and discipline was bad, and the attitude of many of the employers was that their juvenile workers were quite "impossible" and that nothing could be done to improve matters. The Ministry of Munitions became alarmed about these conditions and set up a Welfare Department to deal with the problem under the direction of Mr B. Seebohm Rowntree. Mr Robert R. Hyde, who had had a great deal of experience with boys in one of the poorest districts of London, was called in to help him. The impartial insight into working conditions in the country which he thus gained convinced him that industry itself should shoulder the responsibility for the health, security and general welfare of its employees, rather than leave it to the State or to nobody. The need for legislation would come later in the standardizing of measures which had proved successful when applied voluntarily. It was expected that in this way, though the rate of progress might be slower, the results would be surer.

There has always been a strong tradition in Great Britain in favour of the voluntary principle, and this is very well exemplified in the new Factories Act which comes into force this year. The Act marks a great step forward in the industrial safety code, but this has only been made possible because progressive firms have shown that care for the health and safety of their workers is not only a humanitarian activity, but a necessity to good management.

The Industrial Welfare Society

With the backing of a number of enlightened industrialists, Trade Union leaders and public men, an Industrial Welfare Society was founded in 1918 with Mr Hyde as its Director. Its membership consists of firms and individuals interested in its work, and the Society acts as a clearing house of information on every aspect of the human problems of industry. It does not attempt to apply any particular welfare scheme to industry as a whole, for it recognizes that geographically and economically the circumstances of no two firms are alike, but it can, out of the wealth of information it has amassed in the last twenty years, advise firms and assist them in drawing up schemes applicable to their peculiar needs. The Director and his staff are constantly touring the country, keeping in contact with industries of every description, and even the largest firms with a progressive labour policy find it useful thus to keep in touch with the latest developments in welfare work. The Society daily receives enquiries on a very wide range of subjects covering material conditions in the factory, lighting, heating, ventilation, etc.; problems of health, safety and security in sickness or in old age; the training of young workers; the establishment of sound and happy relationships; social activities during leisure hours; and problems of welfare outside the factory such as housing and transport. The Society does not, however, concern itself with the political controversies over hours and wages, since these are matters for collective bargaining and agreement between employers' federations and the trade unions.

THE INDUSTRIAL WELFARE MOVEMENT IN GREAT BRITAIN

New Basis of Society

It used at one time to be the fashion to blame the advent of the machine for all the evils that came in its train, but since the machine has come to stay, human beings must adapt themselves to the new condition of life and work within it for improvement, instead of railing against material progress. The development of industry on the material side has been so rapid in the last hundred years that it is hardly surprising that development on the human side could not keep pace with it. The whole basis of society has been altered. The old relationship between master and man that existed in the mediaeval craft guilds, when master and apprentice worked together and it was to the advantage of the master that his apprentice should be fully trained in his craft, has disappeared with the growth of industry on a large scale, and the employer can no longer know even the names of the majority of his workers. Therefore the problem today is to create a new relationship to fill the gap.

Duties of Labour Managers or Welfare Supervisors

The enlightened employer now realizes that if he is to make his workers happy and efficient, he must himself be responsible for establishing good relations with them and train his young workers so that they may be fitted to take posts of responsibility in the future. A great deal has been achieved by welfare workers within the factory. It is not always realized that in all the well-organized firms of today there are a number of people who are not primarily concerned with actual production, but whose job it is to watch over the wellbeing of the workers and see that they are doing the work for which they are most suited. Until quite recently labour was chosen haphazardly and generally the choice was left to the foreman or manager whose time was already fully occupied otherwise. Now we find as a recognized part of good management the post of Labour Manager or Welfare Supervisor, who interviews candidates before appointment, watches over their progress and must be consulted before notice can be given. These people, holding as they do a position midway between the management and the workers, act as a link between them, and if they can gain the confidence of both sides, are the strongest factor in harmonious relationship within the works. The employees know that they can go to them for advice, and can make their complaints to them in confidence. Such a state of affairs was undreamed of before the War, and the general recognition today of the value of the welfare worker in industry is the measure of the advance made since then.

It is essential, however, that the right persons should be chosen for these important posts and that they should have proper training. Most of the provincial universities now run special training courses for welfare workers. The Industrial Welfare Society advises people on training and also keeps a panel of suitable candidates for the benefit of their member firms.

Medical Aid to Workers

Industry has not only opened its doors to the welfare worker, but to the medical man, and progressive firms now have their own medical departments, often with a full-time doctor to supervise the health of the factory and research into occupational diseases. His work is mainly preventive and therefore of the utmost importance. New processes and new substances often produce unknown hazards and have to be watched carefully lest they should affect those who are handling them. Firms who have taken on these medical men have stated that the cost of their salaries has been more than repaid for in the increased health and efficiency of the employees.

Training in safety work, especially among juveniles, is an important recent development. The analysis of accidents contained in the annual report of the Chief Inspector of Factories shows that the greatest number of accidents occur to young persons between the ages of 18 and 25. About 60% of these accidents are due not to the machine, but to the thoughtlessness of the human beings employed on them. This is hardly surprising when it is remembered that a child who leaves school to join a factory is plunged into a totally different atmosphere from that to which he is accustomed, and is constantly in contact with rapidly moving objects which produce hazards which he has never had to face in the slower-moving life of his home and

school. It is not likely that in two or three generations man can so acclimatize himself to the great industrial changes that have taken place, that training in self-protection will not remain one of the vital duties of the labour department of any firm. Amazing progress can be and has been made in teaching juveniles the necessary safety precautions at work. On entering the factory they are inexperienced, but not unteachable. They have probably brought to their new jobs freshness and enthusiasm, and if this can be directed into the right channels it can be of great value.

Need for Trained Labour—Continuation Schools

Similarly, industry can ill afford to lose the opportunity of training skilled workers for the future. It is a common fallacy that unskilled labour is all that is required in this machine age. Very specialized skill and knowledge is needed in the handling of many machines, and technical education should go hand in hand with the practical training acquired in the workshops. It is absurd to think that at the age of 14 or 15 a boy or girl has finished his or her education. In actual fact that is just the age at which education will be most profitable, and if juveniles through economic circumstances must leave school at that age to enter industry, it is important that they should have opportunities for continuing their general education and acquiring specialized knowledge suitable for their particular trade. Technical education has thus grown up in Great Britain to fill up this serious gap in the educational system as a whole. All municipal authorities now provide evening classes in general subjects and, if there is sufficient demand, in specialized subjects also. In addition to this the larger towns have highly organized evening technical institutes, which give courses in science and technology of the same standards as the universities. The cost of technical and evening classes is amazingly low, and there is thus every opportunity for the keen juvenile who wishes to improve his knowledge. There is, however, the handicap that after a day's work in the factory the young worker is not sufficiently alert mentally and physically to take the full advantage of these classes, although he carries on often with heroic determination. To overcome this difficulty, some of the more enlightened firms have provided special classes during the working hours, and the experiment has proved well worth while.

Paternalism not Wanted

On the social side of life good work is being done by industry in Great Britain today, but it is now generally recognized that anything savouring of "peternalism" will be unpopular. The British workman is very independently-minded and will reject what appears to him to be ' interference " with his leisure time. On the other hand, there are not nearly enough facilities provided by municipal and private efforts to supply the social needs of the people, and industry can do a great deal in the way of facilities for sports and social clubs. Much depends on the geographical circumstances of the firm and the amenities available locally, and therefore the provisions made for leisure activities vary enormously. The most successful clubs are those run entirely by the workers or by a joint committee of workers and representatives of the management or the welfare department. Sports grounds and club rooms are expensive items which the workers cannot provide for themselves; but they can organize the games and the social events. Moreover the sense of responsibility thus induced will help to make them more useful members of any community. Every encouragement is given to firms to expend money on welfare activities, for these are allowed as trade expenses in the assessment of the firm's liability to income-tax. It would be impossible to enumerate all the recreational activities of large firms, so wide is their scope, and many have developed to a high degree the talent among their workers. As a single instance we might cite the firm which has held exhibitions in London of the art of its workers, not only those in its English factory, but in branches overseas.

Outside Welfare Work

There are other forms of outside welfare work which, according to the situation of the firm, may assume importance. Such are questions of housing and transport. The problem of housing is only acute in certain new areas, but the problem of transport to and from works is becoming more and more serious. These difficulties are bound to have their effect on the health of the workers and their solution is as important as suitable conditions within

the factory and the provision of canteens where the employees may purchase good meals at reasonable prices.

A very great deal still remains to be done in the improving of working conditions, and the prevention of accident and disease, but the progress made in the last twenty years is encouraging. Moreover the movement is spreading slowly but surely in other countries. The Industrial Welfare Society is constantly receiving enquiries from all over the world, and these wide-flung contacts encourage its members in the belief that the principles on which it has been working are equally applicable to industry everywhere.

Indian Conditions

India is marching towards industrialization. The only remedy for the appalling poverty of her people and their general low standard of living lies in the development of her industry. This industrial development must be well planned according to her national need, and the working class must enjoy their due share of purchasing power from industry. Industrialists, with the exception of a very few, have so far been callous and careless of the welfare of the workers. They should realize that, if the present state of affairs continues, Trade Unionism is bound to get a strong hold. Trade Unionism should not be deprecated in so far as it makes the people realize the value of unity and fosters democratic ideas, but so long as the workers remain ignorant and illiterate they will fall easy preys to the strike committee or so called " leaders " who incite the masses to militant violence in order to gain their own personal or political ends. Industry will not be able to stand the shocks of strikes and quarrels, in the early period of its growth.

Though economists may say that giving higher wages to Indian labour does not increase their efficiency but on the contrary increases absenteeism and insolence, this state of affairs will change with literacy and education. So long as it does not change, the employers can get more efficient results and good-will from the workers by giving them better conditions, first inside the works, and then outside, by providing better housing, transport facilities, etc. Contrary to the workers' idea in Great Britain, a certain amount of paternal outlook on the part of the employers will not be resented by Indian workers, and this specially applies to small-scale and moderate-sized industries. Leaving aside the question of temperament of the people of the two countries which may or may not be different, " paternalism " ought to be favoured in India, when opportunity for education or recreation is so limited. A good example of conditions suitable to this " paternalism " is to be found in Zlin, Czechoslovakia, where the great Bata Shoe Company has its works. Here every phase of workers' life is catered for by the firm. Houses have been built and transport provided for the workers. Education, recreation and even religious activities are organized by the firm for the employees and their families. Madame Bata personally supervises the education and welfare of young workers.

Though India is handicapped by starting late, she can benefit from the experience of countries that started industrialization earlier. If she can thus avoid the ills and evils that accompanied industrialization in the West, her late start will be more than compensated.

In conclusion, mention should be made of a book, *Industrial Welfare in India* by P. S. Lokanathan, University of Madras Economic Series, under the general editorship of Prof. P. J. Thomas. Published in 1929, this book may be said to be out of date, but it is quite comprehensive. It deals mainly with the evolution of Factory Legislation and Trade Unionism and touches on important points in general welfare.

Note The Industrial Welfare Society, an account of whose work has been given in the early part of this article has its office at 14, Hobart Place, London, S.W.1. It supplies valuable information and suggestions to firms who are its members. Any firm can become a member on paying a small annual subscription, and an individual can also join by paying still smaller subscription. The Society publishes a monthly magazine which deals with many interesting and important problems arising in industry. Though primarily concerned with national problems, the Society has many international contacts. Until a similar organization is started in India, dealing with her own problems, Industrialists and Employers interested in welfare work in their factories can obtain useful information from the Director of the Society from the address given above. So far only one Indian firm happens to be its member.

Notes and News

Brighter than Sun

All light-sources we use today are highly inefficient from the scientific point of view because only a very small fraction of the energy which is consumed is converted into light. For example, in a modern gas-filled tungsten filament lamp only about 2.5 –5.0 per cent of the total energy is returned as light, the rest being wasted.

In their search for light-sources of higher efficiency scientists are now paying more and more attention to gaseous discharge lamps. In these, light is produced by passing an electrical discharge through appropriate gases or vapours. It is obvious that those substances whose spectra contain bright lines in the visible region (preferably in green and yellow) will be more efficient than the rest. Neon, sodium vapour and mercury vapour which more or less satisfy this condition have found general application in this type of lamp. The efficiencies of these lamps are as follows:

Sodium vapour	.. 8 12	per cent
Neon ..	.. 2.5 6.4	,, ,,
Mercury vapour	.. 2.5 8.0	,, ,,

Mercury vapour lamps fall into three groups depending upon the pressure of mercury vapour at which the lamp works, the type utilizing pressures greater than one atmosphere being most efficient (energy 6.4-8.0 per cent).

One of the most interesting types of high pressure mercury vapour lamps is that developed by C. Bol and W. Elenbaas of Holland. It consists of a quartz capillary about 4 mm. in diameter in which are sealed oxide coated tungsten electrodes about 18 mm. apart. The capillary tube contains a small drop of mercury and argon gas at low pressure. Argon only helps to initiate the discharge between the cathodes which are thereby raised to a temperature at which they act as thermionic sources. Owing to high energy input the mercury becomes vapourized and the pressure of mercury vapour usually exceeds 10 atmospheres. By cooling the tube in a rapid stream of water the energy input of the lamp can be increased many times and thereby the intrinsic brilliancy of the lamp is also tremendously increased.

Elenbaas has reported that by increasing the power input in the water-cooled lamp to 1400 watts per cm. in a 1 mm. diameter tube, a brilliancy of 180,000 candles per sq. cm. has been attained. This is in fact higher than that of the sun as observed from the earth which is about 165,000 candles per sq. cm. It would be of interest to note that in this lamp pressure of mercury reached about 200 atmospheres and the temperature at the axis of the capillary tube was calculated to be about 8600°C., though much less near the wall.

Transforming Ultraviolet to Visible Light

It is known for a long time that a large number of substances such as silicates and sulfides of zinc and cadmium emit light when ultraviolet light falls on them. In other words these substances are able to convert invisible ultraviolet light into visible light. Each substance gives out characteristic light and also has its own range of exciting ultraviolet radiation.

In low pressure mercury vapour lamps a large amount of energy is wasted as invisible ultraviolet light. By coating the inside of the tube by a suitable fluorescent substance a part of it can be converted back into visible light. The colour emitted and the luminous efficiency vary with the composition and the mode of preparation of the fluorescent material. By using a specially prepared zinc silicate G. Inman of the General Electric Co. of America has succeeded in obtaining a light of green colour at an efficiency of more than 60 lumens per watt, the energy utilization ratio being 9.6 - 12.9 per cent.

NOTES AND NEWS

Geological Work in 1937

The Report of the Geological Department for 1937, which has recently been published, shows that the year has been one of considerable activity for the Geological Survey of India. Of the 82 earthquake shocks reported to the Survey, only that of November 14, 1937 originating in the Hindukush Mountains, north-west of Drosh in Chitral, was severe and caused damage.

At headquarters in Calcutta re-arrangements in the laboratory were completed in order to cope to the best advantage with the large number of enquiries received, and rock-section-cutting machinery and an automatic section-polishing machine were installed. In the Museum the show-cases were reconditioned, and the meteorite collection was overhauled and largely added to by exchange with foreign museums. In the fossil galleries re-arrangements have been carried out with a view to increasing their popular appeal. Labels in Bengali, Hindi and Urdu have been printed, describing in simple language some of the more interesting forms and the restoration drawings displayed illustrate the various stages in their evolutionary history. A general account of the exhibits in the Siwalik gallery has been prepared as a wall chart by the Palaeontologist and translated into Bengali, Hindi and Urdu.

Economic enquiries were conducted by members of the Department on bauxite in Jashpur State; Coal in the Hazara and Kohat districts, North-West Frontier Province, Mianwali district, Punjab, and the Garo Hills district, Assam; gold in Jashpur State and in the Katha district and Mongmit State, and on iron-ore in Bastar State, Eastern States Agency, and clays and building materials at several localities. Numerous occurrences of other minerals were examined by members of the Department and found to be of no economic importance, and at the headquarters office over 600 determinations were made of specimens sent in by the public and advice given on their economic utilization if possible. A number of enquiries were also received by the Geological Survey of India regarding building materials, particularly with reference to cement industry. Summarized reports on the various limestone, clay, gypsum and coal occurrences of India were in reply issued by the Department. A survey was made of the Mardan district in the North-West Frontier Province for its marble and dolomite deposits and the conclusion reached that perhaps the largest deposits of pure white statuary marble in the province will be found in the Gundai Tarako, the best sites for development being in the neighbourhood of the main peak of the ridge.

The Department's advice was sought on engineering schemes such as the preservation of the Elephanta Caves, the Malakhand Hydro-electric Schemes and power for Hazara district, North-West Frontier Province, the Pench River (Central Provinces) and the Tons River (Rewah) Hydro-electric Schemes, the Nindeh reservoir, United Provinces, and water supply schemes in Rewah, Darjeeling, Belgaum, Jubbulpore, Baluchistan, Kangra and Jashpurnagar.

For actual geological survey purposes the Department is divided into four circles: Burma, North-eastern, North-Western and Southern. Since the 1st April 1937 the first-named has been separated under the designation of the Burma Geological Department, but the Geological Survey of India supplies the personnel for it. Geological mapping in Burma was continued between Mandalay and Thabeitkyin and north of Thabeitkyin, in the Amherst district, in the Kyaukse and Meiktila district and in the Yengan State. Most of this work was on the Plateau limestone and younger rocks, metamorphosed by intrusive granites. The north-eastern circle's work lay in the Garo Hills and Khasi and Jaintia Hills districts of Assam, on the Shillong series of ancient sedimentaries, intruded by granite, which form the basement of the Shillong plateau, and are overlain by Cretaceous and Eocene beds on the top of the plateau.

In the North-Western circle mapping proceeded in Waziristan, until it had to be discontinued owing to tribal disaffection, in Baluchistan, the North West Frontier Province, Kashmir, the Punjab foothills, the Simla Hills and the Garhwal Himalayas. The members of the southern circle continued mapping the ancient rocks of Peninsular India in the Eastern States Agency and in the Bhandara and Drug districts of the Central Provinces.

A large number of fossil specimens were collected by the members of the Department. They have been examined by Indian and foreign specialists, and 4 volumes of the *Palaeontologia Indica* were published in addition to 9 papers in the *Records* of the Department. Further investigations on the fossils are said to be proceeding.

NOTES AND NEWS

Indian Chamber of Commerce on River Problems in Bengal

There are nearly 15,000 miles of Inland waterways in Bengal and their importance for irrigation and as means of transport and system of drainage is vital to the agricultural production, public health and economic life of the Province. Although the rainfall in Bengal is heavy it has an uneven distribution and a progressive irrigation policy would, therefore, immensely increase the crop value of the Province. These waterways however, as already recognized by the Irrigation Department Committee of 1930, are not maintained in as efficient a state as their importance demands and their neglect along with certain other mistakes in policy have led to deterioration in the productivity of the soil and in public health particularly in Western and Central Bengal. The Committee of the Indian Chamber of Commerce, Calcutta, in course of a communication addressed to the Government of Bengal on the subject of River Problems in Bengal agree with the criticism of the policy of constructing embankments which have obstructed the flow of rivers and upset the entire regime of waterways. This policy has been responsible for increasing the flood menace and the Committee, therefore, favour a policy of abandonment of embankments in order to secure adequate distribution of water. While suggesting that the possibilities of developing Hydro-Electric power particularly in North Bengal should be investigated, the Committee state that the waterways in Bengal offer immense possibilities for the development of inland navigation. Water transport is cheap and, in a deltaic province like Bengal, very essential. It is regrettable, however, that the waterways which have peculiar advantages as a form of transport have hitherto been neglected and the Committee suggest that unless the waterways of Bengal are to suffer continuous deterioration they should be co-ordinated and controlled by authority which should have the powers as well as the financial and technical resources to carry out excavation, canalization, dredging, drainage and other works which are essential for maintaining and improving their efficiency. Improved waterways can prove useful for the economic developments of the Province. The Committee point out in this connection that even in the highly industrialized countries of the West considerable importance is attached to the development of inland navigation which is particularly useful for the carriage of cheap and bulky goods like agricultural produce and raw materials. It is recognized that without waterways, the development of the country's transport and trade is not complete. The Committee quote the opinion of the Royal Commission on the canals and Inland Navigation of the United Kingdom which stated "that the annual cost of maintaining the water ways is almost met by the receipts from the dues but the state expects no return or profit upon the money spent upon construction and large improvements because these works would increase the commerce and wealth of the nation and thereby strengthen the national public revenue." In the United States also when Mr Hoover was the President, he insisted that " we should visualize our inland waterways as great, consolidated transport systems rather than as disconnected individual river and canal improvements".

The Committee of the Indian Chamber of Commerce rightly emphasize the vital necessity of a navigable route between Calcutta and the rest of Bengal and point out that the water traffic in agricultural commodities and raw materials could be more actively encouraged. They also stress the necessity of the Government training up a cadre of Indian engineers to specialize in river-engineering and to acquire knowledge and experience of conditions and problems connected with deltaic rivers.

Business Career for Calcutta University Students

It will be remembered that in June 1936, the Vice-Chancellor of the Calcutta University approached Sir Edward Benthall, the then President of the Bengal Chamber of Commerce, with a scheme for the provision of practical training for selected students of the University in different branches for trade, industry, and commerce with a view to changing the outlook of University trained men in favour of business careers, and he was assured of the support of the Chamber. It was then realized that the University should set up an Appointment and Information Board to maintain touch with business houses and " to give full and impartial advice on the merits of the candidates available." The work of the Board commenced in May 1937. The report of the first year's working of the Board says that already 62 European and 21 Indian business houses have agreed to co-operate with the University.

It is gratifying to note, says the report, that the procedure followed in the matter of registering and recommending candidates has been approved by the

business community. Though this department has been functioning only for a year out of which about four months had to be devoted to establishing contact with the business community and evolving the procedure, the method of action and the lines of approach, it has been able in the course of this short period to find places for 60 young men, a result which can be compared very favourably with the first year's achievement of the Appointment Boards of British universities. Some of the lines in which these candidates have been placed are jute spinning and weaving, jute baling, purchasing and assorting, steel trade, coal trade, insurance, banking, tanning, salesmanship, chemical research, air conditioning, engineering, telephone construction and maintenance, electrical and hydraulic engineering, etc. The report says "that regular inquiries are made regarding the candidates associated with the different business houses to find out how they are shaping and progressing with their work. It is satisfactory to note that in every case the report received has been favourable, which proves beyond doubt that, given the opportunity and facilities, Bengali young men with a University training can do well in business provided a careful selection is made of the candidates." Most of the candidates interviewed, the report adds, were more keen to know about the prospects which commercial line would offer. But this is difficult if not impossible to answer, because in business there are usually no defined scales of salary such as obtained in other callings, and prospects depend almost entirely on the man himself. At the same time it was noticed that some of the candidates interviewed were afraid of hard manual labour and were more keen either to enter the Government services or in accepting jobs with a graded scale pay and some status from the beginning. It would thus seem that it is necessary to take effective steps to change the outlook of Bengali students who generally lack enterprise and adventure perhaps due to want of confidence which again is not always the fault of any individual. If it be possible to engender a spirit of enterprise and love for a commercial career in the minds of young students while attending schools, and if guardians would try to impress on the young minds that the days ahead are full of struggle for which every one must be physically and mentally fit, this may go a long way towards changing the outlook of the average Bengali youth.

One of the leading business houses of Calcutta, sates the report, has made a proposal to take in 30 matriculates between 15 to 17 years of age, who would in the first instance, be trained as office boys. The idea is that after getting them trained as office boys for two years, during which time they would be given a salary of Rs. 20 per month, they would be appointed as junior clerks provided they pass the Intermediate Examination with commercial subjects. They can pass this examination by attending the evening classes and the company is prepared to pay the tuition fees. After being appointed as junior clerks, if these young men can pass the B. Com. examination their positions will be improved. This proposal is now under consideration.

Dry Farming Experiments by the Imperial Council of Agricultural Resarch

In those parts of India where rainfall is scanty and precarious the growing of crops presents great difficulties especially where irrigation facilities are absent or limited. But if the farmer could be taught a way of preserving the moisture in the soil and of tilling it in a scientific manner, his difficulties would be greatly decreased. This task has been undertaken by the Imperial Council of Agricultural Research, which is making a series of experiments in what is called *Dry Farming*. In America, especially in Utah, this method has been applied with great success. These principles have, however, to be adapted to Indian conditions and requirements. The Imperial Council of Agricultural Research has established five stations in different parts of India which are in different stages of experimental development. Their activities are, however, all co-ordinated by a special Co-ordinating Committee for Dry Farming. This Committee sees that the methods employed are standardized, that the activities of the various stations are co-ordinated, and compares their methods and results.

It is probable that at least twice as much may be grown by dry farming methods as is being now done. The great merit of this dry farming method is that it does not increase the cost of production at all. All it requires is a little more labour which under Indian conditions in these parts is available at little or no cost. Already the peasant has so much of leisure at his hands that he can very well utilize it for getting a better return from the soil. The areas selected are those especially in need of this method of farming. Stations have already been established at Sholapur, Bijapur (Bombay), Hagari (Madras), Rohtak

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(Punjab), and Raichur (Nizam's Dominions). The Bombay and Hyderabad schemes were begun in 1938; the Punjab in 1936. The stations at Hagari and Sholapur are carrying out detailed soil investigations while those at Raichur and Bijapur are concerned more with local problems. The stations in South-West India are testing the "Bombay Dry-Farming method" whereby crops alternate with fallow periods. The water requirements for *juar* are tested at Sholapur and those for Bajra at Hagari. Hagari has the lightest rainfall. The soil there is, however, deeper and the slope less than at other stations. Hagari also carries a larger range of crops like *juar*, Italian millet, and cotton all of which have their importance. At Sholapur rabi *juar* is most important.

Perennial canals and wells have, by irrigation, secured a large area in the Punjab against famine, but a great area still remains unsupplied for. The south-east of this province is only too familiar with crop failures; the provision therefore of famine work is almost an annual necessity. Out of the 6.7 million acres of crop in the five districts in the South-East, namely, Hissar, Rohtak, Gurgaon, Karnal and Ambala, 5.4 million are entirely dependent on rainfall. A dry research farm has therefore been established at Rohtak about 40 miles North West of Delhi. The depth of the water level makes irrigation from wells usually impracticable; the water is even saline. Only in July, August and September, is there any rainfall which averages about 20 inches but varies enormously. Rohtak itself however has canal water which may be used. The experimental farm in Rohtak has both light and heavy soil. The heavy soil is alkaline at lower depths. Soil survey and studies in plant physiology are being vigorously carried on under expert direction. Soil surveys are being made up to a depth of 10 ft. The penetration of rain water on crop and fallow land is being experimented upon and measured. So also is the loss by evaporation under different conditions. The field work consists in finding the effects of deep and shallow cultivation on the absorption of rain water; on the effect of surface cultivation after showers of rain; on the interculture of crops; the value of bunds in conserving rain water; the effects of varying the seed rate and farm yard manure; and different rotation of soil moisture and crop yield. These dry farming experiments have now reached the third year of the five years for which they have been planned. All the major crops of the Punjab that are cultivated in these districts have been successfully grown by the Rohtak farm.

Development of Broadcasting in India

Attention has recently been directed to developing Broadcasting in India. The All-India Radio have opened four new wireless stations, one each at Lucknow, Delhi (shortwave), Lahore and Bombay (shortwave). They are adopting shortwave lengths for transmission as a part of their policy of developing the service regionally. To counteract the difficulty of transmission due to atmospheric disturbances and also to divide this large tract of India into provincial regions, the All-India Radio, in agreement with the International Tele. Communications Conference held recently at Cairo, have reserved wavelengths of 60, 90 and 150 metres for the new Indian 10 K.W. stations for service after sunset while during the day wavelengths of 31 and 49 metres are used without any interference to offer long distance services.

These wavelengths have been chosen advantageously, following the report of an English Committee on transmission in tropical and sub-tropical countries, for serving the provinces in a better way. The reception under these conditions is satisfactory in spite of the natural hindrances up to a distance of about 500 miles. Much shorter wavelengths may serve much longer distances satisfactorily but only at the cost of bad service for the area round about for which the transmission is primarily intended. For serving whole of India, the headquarters station of the All India Radio at Delhi is shortly going to instal a 5 K.W. shorter wave station with a silent zone or skip near about Delhi. The paucity of funds, it has been argued, has compelled the authorities to establish one extra station at Delhi after depriving Bombay, Madras and Calcutta of shortwave transmitters. It is expected that the next part of the programme will be divided towards Calcutta, Madras, Trichinopoly and Dacca.

The Central News Organisation at Delhi will radiate news bulletins by the 10 K.W. station for distances up to 500 miles and also by the 5 K.W. station for distances beyond that limit. The latter station will operate on 19 metres during daytime and on 31 metres at night. Unlike European stations, these shortwave transmitters will not employ directional or beam aerials. It is useless as far as the programmes are meant for Indian listeners only.

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The good reception of the programmes from abroad is due to the effective strength being increased by those special aerials to, say from Daventry, 1000 K. W. and more as against 10 K.W. of Bombay, as received at Delhi and secondly for longer distances shorter wave lengths as transmitted from foreign countries ensure practical immunity from tropical atmospherics. But this new specification of wavelength from the regional stations will, it is hoped, give no cause for complaint from the listeners.

Distribution of Mohenjodaro Relics to Provincial Museums

A scheme of wide distribution by which the principal museums in India will be given, for the education and those who visit them, collections of antiquities discovered in the excavations at Mohenjodaro, Sind, is under consideration in the Archaeological Survey of India. Everything unique discovered at the place will of course be placed in the Museum built at the site of the excavations by the Government of India to house the antiquities and facilitate their study in relation to the ruins where they were discovered. After the requirements of this main museum have been met, collection of antiquities will be made available to the principal museums all over India. Already the Indian Museum at Calcutta and the Provincial Museum at Bombay have each been given a collection of about 2,000 antiquities. The first choice was given to these institutions, for the Indian Museum at Calcutta is an All-India institution while the Museum at Bombay happened at the time of these excavations, that is to say, before the separation of Sind, to be museum of the province where the discoveries were made.

A new Mohenjodaro gallery has recently been opened in the Prince of Wales Museum, Bombay, for the proper display of these relics of the oldest civilization of India. To each of the museums at Madras, Lucknow, Patna, and Nagpur have been given collections of about 500 articles each and special arrangements for these much prized relics have been made at all these Provincial Museums. A special collection of over 500 antiquities has been kept reserved for the Province of Sind and will be handed over to the Victoria Museum, Karachi, as soon as steps have been taken to provincialize the institution and to ensure that the antiquities will be well looked after and properly exhibited. No allotment has been made to the Punjab museum at Lahore as it will soon receive a rich collection of the antiquities discovered at the excavations at Harappa within the Province. For the purpose of this provincial distribution, the museum at Peshawar could not be considered, as the Victoria Memorial Hall, where 90 percent of the exhibits were those discovered by the Archaeological Department at Takti-e Bahi, Jamalgarhi, Sahar-i-Bahlol and Shahji ki Dheri within the province in the excavations conducted during the last 30 years, and which therefore served as the Museum for the province is now in complete ruins as the result of a roof collapse which took place recently. No presentation is being made to Assam, as that province has no museum of its own yet, but as there is a proposal to build one shortly, a collection of the Mohenjodaro antiquities is being reserved for presentation to Assam too. There is no provincial museum for Orissa and until one is brought into being, presentation of these antiquities to Orissa is not possible.

It is also proposed to make presentations to the museums in the principal Indian States such as Hyderabad, Mysore, etc., on a reciprocity basis, provided the States take steps to properly display these antiquities. It is hoped that as a result of this arrangement not merely will the States be placed in possession of the valued antiquities discovered at Mohenjodaro, but all Indian museums will also get in return sets of duplicate articles from the State museums.

Prehistoric Finds at Maski

The Nizam's Archaeological Department took up recently the task of excavating and bringing to light ancient centres of civilization. Maski, situated 72 miles southwest of Raichur on the right bank of the river of the same name, is one of the places where such excavations have been made with fruitful results. Although at present it has a population of just about 4,500, the excavations indicate that Maski must have been at one time a town of considerable size and importance. In the course of excavation traces of furnaces for smelting gold and iron have been found, and beads, pieces of *chank* bangles and terra-cotta figurines have been unearthed. When the earth was passed through fine sieves, beads in particular, were found in great abundance in a variety of colours and shapes, which shows that Maski was once an important centre of the bead industry. The bead industry of Paithan, another ancient town in the State, and the export of beads to western countries

have been referred to in the works of various writers, but research in recent times has proved that beads were exported also to eastern countries such as the Malay Peninsula, though at a much later date, namely, the seventh and eighth centuries of the Christian era. The finds at Maski further indicate that *chank* was largely used for various kinds of ornaments such as rings, bangles, necklaces and earrings, and that the *chank* industry must have been one of the principal industries of ancient Maski. Among the terracotta articles which have been brought to light, are human and animal figurines, circular discs grooved along their edges, wheels of toy-carts and beads. In the opinion of the Archaeologists, the human figurines belong to different periods. Noteworthy among the finds is a tiny cobra head of amethyst, which, it is surmised, may simply be ornament or indicate Naga worship. The potsherds and complete vessels that have been unearthed also offer a great variety and belong to different periods. Black and red polished vessels have been found in close proximity to human bones among which were two skulls which have been sent for examination to the Zoological Section of the Indian Museum and a report as to their character and age is awaited. The above discoveries have led Archaealogists to believe that Maski was an important place in pre historic as well as historic times. The black and red funeral pottery, polished stone implements and chert flakes, in their opinion, belong to 1,000 B.C. or earlier. The bead and *chank* articles and some of the terra-cotta figurines range from 500 to 300 B.C., while the seal impression, ornamental pottery and some terra-cotta figurines range from 300 to 100 B.C. Some specimens of glass bangles also may belong to the same period, but the majority are of a much later age. These valuable and interesting finds have been scientifically arranged and accommodated in a separate section of the Hyderabad Museum.

The Brazilian Academy and Indian Scientists

Prof. B. N. Singh. D.Sc., Kapurthala Professor of Plant Physiology and Agricultural Botany, Benares Hindu University, has been, we are glad to know, the recepient of an international honour (a "Diploma of Honour" and "Medal of Scientific Merit") from the Academia de Sciencias e Artes, Rio de Janerio (Brazil). The Academy has been awarding this rare distinction to select workers of the world on an international basis in the recognition of definite fundamental advances made in the realm of science or arts.

Prof. Singh is the author of a large number of original papers in the fields of plant physiology and nutrition, bio-chemistry, agronomy, soil science, general biology and plant pathology, which were published in the leading scientific journals of the world. Under his inspiring guidance the Institute of Agricultural Research of the Benares Hindu University of which he is the director, "is doing great work and laying a fine experimental foundation". The January 1938 issue of *Science & Culture* published an article by Dr Singh, titled "Biology of Longevity and Death", which received wide tributes from the foreign delegates of the Silver Jubilee of the Indian Science Congress.

The same honour, we are glad to say, has been conferred by the Brazilian Academy on Dr B. C. Guha, Professor of Applied Chemistry, Calcutta University and Honorary. Director of the Department of Bio-chemistry and Nutrition, Indian Institute for Medical Research, Calcutta, and on Dr H. N. Mukherjee of the Bio-chemical Department, Carmichael Medical College. Dr Guha is well known for his researches on vitamins and related subjects and Dr Mukherjee for his work on insulin and allied themes.

We wish the three scientists long careers in the service of science and further distinction to their country and themselves.

SCIENCE IN INDUSTRY

White Sugar from Coloured Canes

A simple and inexpensive process for the production of brilliant white sugar from coloured canes, which should help to fill a long-felt want in the Indian sugar manufacturing industry is described in the *Indian Industrial Research Bulletin* No. 11 entitled "The Manufacture of Sulphitation Sugar from Coloured Canes (Purple Mauritius)".

In order that existing factories may treat coloured canes without the installation of additional plant, the author, Mr. S. Venkata Ramanayya, B.A., M.Sc., confined his investigation to the sulphitation process, which is the one used in most factories for the clarification of cane juice; Mr Venkata Ramanayya describes at length his laboratory experiments and successful large scale tests to produce white sugar from the juice of Purple Mauritius. There is no reason to suppose that a process which is successful with the Purple Mauritius should not also be effective with other coloured canes.

The cane Purple Mauritius has for several years been a favourite with the ryot on account of its heavy yield per acre, and because by simple liming and skimming the ryot is able to obtain from it a hard jaggery of good appearance. Unfortunately, hitherto, in the vacuum pan factory where juice sulphitation is generally employed for the manufacture of white sugar, this cane has not been popular. The Purple Mauritius' juice, even when clarified, has an intense red colour, and the sugar manufactured from it without special treatment to remove the colour is dark brown.

But the heavy yield per acre, the soft texture of the cane and the high purity of the juice obtained would make the Purple Mauritius an attractive raw material for sugar manufacture, if some means could be found to overcome the colour difficulty. The solution has now been supplied by Mr. Venkata Ramanayya. His laboratory experiments have shown that the controlled addition of aluminium hydroxide to the cane juice, after the usual liming and sulphiting operations, removes the colour entirely without decomposing the sugar.

The *Bulletin* also describes a cheap and simple method of producing the aluminium hydroxide at the site of the factory. Commercial potash alum, which sells at about half an anna a pound, when decomposed with lime yields a bulky precipitate of alumina cream. The calcium sulphate that is formed as a product of double decomposition is an undesirable impurity and tends to form heavy scale on the heating elements of the evaporators. It will, therefore, be necessary to wash repeatedly the bulky cream of alumina with clean fresh water in order to eliminate the calcium sulphate completely before use.

Large-scale experiments carried out by Mr Venkata Ramanayya at the Etikoppaka Sugar Factory have proved that the manufacture of white sugar from Purple Mauritius by the application of alumina is not attended by injurious chemical changes, that entirely white sugar results, and that the process is practicable economically, as on an average only one pound of commercial alum is required per ton of cane ground.

Industrial Programme for Bengal

We understand that the Hon'ble the Finance Minister of the Government of Bengal has submitted an industrial programme for the consideration of the Government. The main outline of this programme may be set forth as follows:

1. The Government should immediately undertake

   (*a*) An industrial survey for ascertaining the various industries in the Province and exploring the possibilities of establishing new ones;

   (*b*) Enquiry into the present activities of the Industries Department; and

(c) Investigation into the possibilities of supplying cheap electrical power over wide areas.

After the results of these various enquiries are available, a planned and co-ordinated programme of industrial development should be drawn up for the Province. Pending the results of these investigations the Government should, however, adopt the following measures:

2. Establishment of an intelligence Section of the Department of Industries for collection of complete and up-to-date information regarding production, demand and distribution of industrial commodities of the Province.

3. Creation of a Stores Purchase Section.

4. Establishment of an Industrial and Commercial Museum and arrange for holding of periodic exhibition in different parts of the Province; also organization of a moving exhibition. The object of these museums and exhibitions would be to establish contact between the producer and the buyer.

5. Arrangement for marketing of cottage industry products by subsidizing selected shops and by setting up selling and distributing agencies.

6. Reorganization (establishment, if necessary) of the existing Technological and Industrial schools and co-ordinating the activities of such institutions with the engineering and scientific institutions of the province, including the two universities at Calcutta and Dacca with a view to providing improved facilities for teaching and for research on industrial problems.

7. Establishment of a Scientific Advisory Council attached to the Government.

8. Reorganization of the Industrial Credit Corporation for financing a larger number of cottage and small industries.

It will be seen that many of the items of the above industrial programme of the Hon'ble the Finance Minister of Bengal have already been discussed in SCIENCE & CULTURE. The scheme drawn up appears to be a fairly comprehensive one, and we hope that it will be given effect to early by the Government of Bengal. The urgent need of the establishment of a Scientific Advisory Council attached to the Government is essential for industrial development, as has been pointed out several times in these columns, and we are glad that the Finance Minister has also felt the advisability of setting up such a Council.

Development Plan for Mineral Wealth in Kashmir

Jungle Gali, 50 miles north-west of Jammu, is an area of some 50 square miles rich in minerals such as limestone, coal, bauxite and China clay deposits and possibly zinc and copper ore. It is proposed to launch a ten-year plan to develop the mineral resources of this area. The plan also includes, according to Mr L. Zutshi, Consulting Mining Engineer to the Government of Kashmir, the manufacture of cement within a year, the opening of coal mines and the construction of hydro-electric power generating stations. Plans for starting cement factories are now complete and it is hoped to start production within a year. The object of these schemes, said Mr Zutshi, was not only to launch industries but also to provide remunerative work for the unemployed in the State.

"Bonded" Concrete Roads

The time honoured water-bound macadam roads, of which there are thousands of miles in India, rapidly disintegrate under the bullock cart and fast-moving lorry and bus traffic, now common on almost all roads. A better and more lasting surface is needed to avoid the expenditure of unjustifiably large sums on ceaseless maintenance work. Cement concrete roads, which are free from this disadvantage, have, since 1920, been laid in various parts of the country. Such road surfaces laid over 10 years ago are even today in excellent condition, and their value as a lasting surface requiring little maintenance has been proved beyond doubt in India.

During recent years, however, partly owing to adverse economic conditions, efforts have been made to cheapen the cost of concrete roads. Mr T. R. S. Kynnersley at a meeting of the Institution of Engineers (India), Bengal centre, read a paper in which he described how it was possible to design economically a concrete road slab from 2 inches to any required thickness to suit all conditions of traffic. If a thin wearing surface of concrete, Mr Kynnersley pointed out, could be efficiently laid on a good foundation, it should provide a very economical solution for thousands of miles of old, well consolidated, water bound macadam roads in India, especially district and provincial roads which did not generally carry very heavy traffic.

Mr Kynnersley described the experiments he had carried out in Bombay in 1933 with thin $1\frac{1}{2}$ inch concrete slabs bonded to the existing macadam base with different

types of light mesh reinforcements. The results obtained had been very satisfactory. Proper specifications had been drawn up and an improved technique of construction developed. These experiments had resulted in further trial lengths being laid in various parts of the country and their performance had been so satisfactory that the Public Works Department of the United Provinces had adopted this method as a "treatment" for certain district roads carrying light bullock cart traffic. This type of construction, to which the name of "Bonded Concrete" had been given, consisted in laying a thin layer of concrete over a macadam road with mesh wire netting. Before laying the concrete cement grout was thoroughly brushed into the intervening layer of metal to bond the new crust with the old foundation.

Superiority of Bengal Timbers

Properly seasoned Bengal timber has stood the test so well in Bengal where conditions are trying for any timber that it can be expected to stand any climatic conditions. Various specimens of timbers were sent to the Forest Research Institute, Dehra Dun, for test and identification. From reports received it appears that Bengal teak has a slight advantage over even Burma and Malabar teak in having a somewhat lower shrinkage, making it more suitable for furniture. Bengal teak offers no conversion difficulties except slight gumming of saw teeth and knife edges as in the case of all teaks. It machines well, turns well, and can be brought to a fine smooth surface by hand without any difficulty. It takes a good spirit polish.

Gas Driven Ships

According to a *Reuter* message, ships driven by gas have now been produced as part of Germany's Four Year Plan for self-sufficiency. The ships have their own gas generator on board and by this means valuable fuel is saved which would otherwise have to be imported. A big Hamburg shipping company which runs the famous trips round the harbour is to operate the first gas-driven ferryboat, the "Leuhe", which has a 250 h.p. gas engine and is capable of accommodating 420 passengers.

1938 Directory of Indian Manufacturers

The activities of the Association for the Development of Swadeshi Industries, Delhi, in the industrial field, especially the organization of annual All-India Industrial Exhibition at Delhi, are already well known. It published last year the first edition of the *Directory of Indian Manufacturers* which became very popular and sold largely. Encouraged by its success, the Association is shortly to bring out a second and improved edition of it. To meet the demand, it has been decided to increase the number of the publication for this edition. It will be, it is claimed, fairly exhaustive, as efforts are being made to incorporate into it all the names and addresses of the bonafide Indian manufacturers, and the inclusion will be free of charge. The sole object of the publication being to help the development of Indian industries and enterprises without any desire on the part of the Association to make profits out of its sale, the price is to be fixed at Rs. 3/15/- per copy.

Our Industrial Article for July

The following article on "Slag Glass" has been contributed by Mr Y. P. Varshney, Assistant Professor of Glass Technology, Benares Hindu University, for our section of "Science in Industry" of the present issue of the Journal.

Slag Glass

Y. P. Varshney

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Of the various ways in which utilization of waste furnace slags from iron and steel plants has been attempted, its incorporation as a consituent in glass-making batches is one. This paper deals with experiments made in this direction with slags produced in the two important Iron and Steel factories in the country.* As this material cannot, for use in glass or cement[1] manufacture, bear ths heavy charges of long-distance transport it must of a necessity be employed close to the place of its origin, *viz.*, near about Asansol and Tatanagar, etc. Consequently, the availability of other necessary raw materials in this locality cannot be left out of consideration.

From the point of view of fuel this area is decidedly the most suitable, as it constitutes the coal centre of the country. Extensive occurrence of good-quality quartz in the vicinity does away with the difficulty of obtaining glass sand, as this rock can be cheaply crushed and used to give the silica content of the glass. Soda ash which is an important material can be obtained from Calcutta and will be cheaper here than in most of the glass factories in all parts of northern India other than Bengal. As orthoclase felspar is abundantly available in this part of the country and can to a good extent be used for replacing the more costly alkali from soda ash, it forms a major constituent of the batches mentioned hereinafter. The use of felspar in large quantities necessarily involves the introduction of a higher percentage of alumina in the glass composition than is used commonly in commercial glasses. This is also a point of difference from other investigations which have been confined to soda-lime silica glasses having very little alumina.

In spite of the divergence of opinion with regard to some minor points, it is generally agreed on all sides that alumina, as a constituent of glass, improves the qualities of the material in many ways. But due to certain difficulties in manufacture, highly aluminous glasses have not been largely used in making hollow glassware. However, at numerous places in Europe cheap containers like bottles are known to be made from such glasses on a large scale. Besides, aluminous glasses are particularly suitable for making pressed ware. Thus it may be confidently expected that such glass cheaply made with the use of slag and felspar can be easily adopted for manufacturing bottles, jars, floor tiles, roof tiles, etc., in various transparent colours as well as in opaque and black varieties.

In all the following experiments three types of slags have been used. Their compositions were as given below.*

	H *Blast furnace*	T_1 *Open hearth*	T_2 *Duplex plant*
SiO_2	25.46%	15-18%	12.60%
Al_2O_3	31.10%	2- 3%	2.78%
FeO	—	9-12%	16.00%
Fe_2O_3	0.70%	3 4 %	9.00%
CaO	35.33%	46 49%	42.80%
MgO	4.16%	8 10%	5.40%
MnO	2.13%	4·5 %	3.26%
S	0.80%	—	—
P_2O_5	—	3-4%	7.02%
Total	99.68%	—	98.86%

The felspar used was an orthoclase of the composition

SiO_2	63.65%
Al_2O_3	19.60%
Fe_2O_3	0.07%
CaO	0.72%
MgO	0.21%
K_2O	12.71%
Na_2O	3.04%
Loss on ignition	0.50%
Total	100.49%

* Tata Iron & Steel Col., Ltd., Jamshedpur.
Indian Iron & Steel Co., Ltd., Burnpur.

[1] Varshney and Misra, *Science & Culture*, *3*, 616-618, 1938.

* Analyses T_1 and T_2 were supplied by Messrs Tata Iron & Steel Co. Ltd.

Other materials like sand, lime, soda ash, etc., were of good purity as commonly used in the manufacture of colourless glass. The experimental melts were carried out in one-pound-capacity fireclay crucibles placed either in an oil fired muffle furnace or in a coal-fired recuperative muffle furnace which was specially designed for the present experiment so as to give temperatures up to 1500°C. In this muffle, recuperator tubes were arranged inside the chimney stack on the top of the whole muffle structure and air which had been preheated through the recuperators was fed partly below and partly above the grate, in the combustion chamber, no cold air being allowed to enter into combustion. The body of the muffle and the crucibles were made of a special composition because it was found that ordinary fireclay could not properly stand the temperature reached. Calcined kyanite was largely used to replace the fireclay grog in making these refractory parts.

A set of compositions were so selected as to give glasses which should be stable, chemically durable and workable at reasonable temperatures and then batches were so calculated as to yield glasses approximating to one or the other of these compositions. The compositions selected were:

	I	II	III
SiO_2	50	50%	56%
Al_2O_3	22%	18%	13%
Fe_2O_3			
CaO	10%	12%	15%
MgO			
Na_2O	17%	18%	15%
K_2O			
Other oxides	1%	2%	1%

In the following melts H_1, H_2, etc., represent those in which slag H was used while that marked T_1 has the open hearth slag and that marked T_2 has the Duplex plant slag. The temperature and time of founding is given in case of each melt.

Melt No. 1.

Temperature 1350°C Time 6 hours.

	H_1	H_2
Slag	100	100
Felspar	300	300
Soda ash	50	50
Pot. nitre	—	12

H_1—Good pale green glass, but more viscous than ordinary glass used in Indian factories. Difficult to free from bubble.

H_2—Good glass; slightly less viscous than H_1 but colour lighter and bubble much less. Addition of nitre seemed to have reduced colour by oxidizing ferrous to ferric iron. Further, it helped the fining of the glass.

Melt No. 2.

Temperature 1300°C: Time 3 hours.

	H_3	H_4	H_5
Slag	100	100	100
Felspar	300	300	300
Soda ash	60	50	50
Pot. nitre		12	12
Borax		5	5
As_2O_3		...	1
Cobalt oxide			0.025
Selenium			0.02

All glasses in this melt were better than in the previous one inasmuch as at a lower temperature they seemed more fluid than those in the previous one.

H_3—Light brown glass with much bubble.

H_4—Brownish tint with little seed. Borax helped the melting as well as fining rate.

H_5—Good glass with a very faint blue green tint, indicating that by adjusting the decolorizer, colour could be rectified to a great extent. In point of viscosity and setting it seemed quite workable, but a good founding temperature appeared necessary.

Melt No. 3.

Temperature 1350°C: Time 3 hours.

	H_6	H_7
Slag	100	100
Sand	150	150
Felspar	150	150
Slaked lime ..	35	35
Soda ash	90	90
Pot. nitre	..	10
Borax	—	10
Arsenic	-	2

Both glasses were good but H_6 was more viscous than H_7 and the colour too in it was of a deeper shade. H_7 was bottle green with no seed and was quite workable.

Melt No. 4.

Temperature 1450°C: Time 4 hours.

	H_8	H_9	T_1	T_2
Slag	100	100	100	100
Sand	150	—	—	—
Felspar	150	300	300	300
Slaked lime	35	—	—	—
Soda ash	90	50	50	45
Pot. nitre	10	10	12	15
Borax	10	10	8	5
Arsenic	4	4	—	—

All the batches in this melt gave good bubble free glasses, but H_8 was the most workable with the greatest fluidity. In colour, H_8 was bottle green, H_9 brownish, T_1 a black glass and T_2 almost colourless with segregations of dark amber colour in numerous places.

Glass H_8 and T_1 on analysis gave the following compositions

		H_8	T
SiO_2	..	56.42%	49.04
Al_2O_3	..	12.42%	14.20
Fe_2O_3	..	0.18%	3.36
MnO	..	0.30%	0.86
CaO	..	12.96%	11.43
MgO	..	1.03%	2.05
Na_2O	..	11.50%	8.46
K_2O	..	4.82%	8.90
P_2O_5			0.70
B_2O_3		not determined less than 0.50%	
Total		99.63%	99.00

The batch represented by H_8 was selected for a trial on a semi-commercial scale. It was melted in a pot furnace of the direct fired type commonly used in Indian factories. The melting temperature being low, *viz.*, 1280°C, the batch took an unusually long time for melting and fining. After 20 hours all the batch had completely melted and after 40 hours it was free from bubble. Owing to the low temperature the glass was very viscous but the good working range still made blowing possible. Pressed ware was also made out of it. A second attempt made with the furnace temperature at 1350°C. was very successful, the glass becoming workable after about 16 hours. The annealing of the lighter blown ware could be done ordinarily but for heavy pressed ware it was found necessary to take resort to slower cooling, otherwise the ware cracked.

It must be pointed out that in these glasses larger percentages of potash give good brilliance and then again as potash and soda are in almost equal proportions chemical durability is good. As observed by Basore[2] in his investigations it was found that these glasses had a marked tendency to break in rounded pieces rather than in angular fragments.

In northern India ordinarily the cost of batch materials for making a soda lime-silica glass comes to about Rs. 2/- per maund; but it is estimated that by using slag batches this cost in the localities mentioned will be reduced by about 50%. Add to this a further saving in the cost of fuel and the advantages are considerably increased.

The writer's best thanks are due to Dr V. S. Dubey for his assistance in obtaining samples of the slags and to Mr M. L. Misra of the Geology Department for help in doing two analyses of the glasses.

[2] Abstract, *Jour. Amer. Cer. Soc.*, p. 219, 1933. (Mfrs. Rec. 102 (1) 68, 1933).

Medicine and Public Health

Our New Feature

From the present issue we are starting a new feature, " Medicine and Public Health " in our Journal. We propose to publish in this section short informative notes on medical topics, and also articles on recent progress in medical science. These will be dealt with, as far as possible, in a semi-popular style, so that they may be readily comprehensible to the average reader. We take this opportunity of thanking all those who have encouraged us either by active co-operation or by useful suggestions or in other ways, in the introduction of this new Section. We also welcome further suggestions towards the improvement of the Section, and invite suitable contributions from medical experts.

Cutaneous Application of Follicular Hormone

The oestrogenic hormone is stated to be absorbed through the skin. Zondek has shown (*Lancet, 1*, 1107, 1938) that if the hormone is dissolved in benzol, ether or alcohol and rubbed over a shaved surface of the body it is absorbed completely. A dose of oestrogenic hormone given in this way is just as effective as the same dose injected subcutaneously. When dissolved in oil the hormone is not absorbed completely. Progesterone however is not so readily absorbed.

—*S. Banerjee.*

Testosterone Propionate on Testicular Function in Monkeys

Androgenic hormones are extensively used in the treatment of hypogonadism and in masculine sterility. But whether androgenic hormones can produce spermatogenesis is being questioned. Observations have been made by S. Zuckerman (*Lancet, 1*, 1163, 1938), on eight immature rhesus monkeys, one drill and two Hanuman langurs on the effect of testosterone propionate. The testicular lobules appear to be closer together in the injected specimens, seminiferous tubules are distended, germinal epithelium in these tubules is immature in disposition and no tubules contain spermatozoa. No changes are observed in the interstitial tissue.

—*S. Banerjee.*

Testosterone Propionate in Grave's Disease

The thyrotropic hormone of the anterior pituitary gland stimulates thyroid secretion. In Grave's disease there is hypersecretion of the thyroid gland. If a hormone be used which inhibits the anterior pituitary function these cases of hyperthyroidism may be treated rationally. Testosterone propionate has been found to suppress the production of gonadotropic substances by the pituitary body (Hamilton and Wolfe, *Endocrinology*, March, 1938). If the male hormone blocks the production of gonadotropic hormone it may also interfere with the other hormones secreted by the anterior pituitary including the thyrotropic hormone. This idea led Dr Loeser, (*Lancet, 1*, 1134, 1938), and Dr Levy Simpson, (*Postgrad. Med. J.*, May, 1938, p. 144) to treat four cases of hyperthyroidism with testosterone propionate. The results obtained are reported to be very promising.

—*S. Banerjee.*

Vitamin B_1 Deficiency as an Etiologic Factor in Pregnancy Toxaemias

A. C. Siddall reports in *Am. Jour. Obst. Gynec.*, *35*, 662, 1938, that vitamin B_1 is necessary for the normal function of the pituitary gland just as iodine is necessary for thyroid function. Vitamin B_1 avitaminosis in non-pregnant females leads to beriberi, the symptoms of which are produced by hypofunction of the pituitary body. The symptoms of beriberi include disturbed carbohydrate metabolism, edema, low blood pressure, atrophy of the ovaries, atony of the gastrointestinal

tract. With the onset of pregnancy the pituitary body enlarges and meets the increased demands with increased function. The requirement for vitamin B_1 is also increased three to five times. So if the intake of vitamin B_1 be not increased hyperfunction of the gland results which is shown by disturbed carbohydrate metabolism (hypoglycæmia), edema, elevated blood pressure, nausea, vomiting, high prolan and low estrin content of blood. These signs are also the features of pregnancy toxæmias. The paradoxical statement that B_1 deficiency leads to hypopituitarism in non pregnant females and hyperpituitarism in pregnant women is explained as follows: the onset of pregnancy produces such changes in the maternal organism that the pituitary body not only compensates for a lack of vitamin B_1 but actually overcompensates to the detriment of the patient.

—*S. Banerjee.*

Pancreatic Hormone in Acute Pancreatitis

Anselmino and his associates (*Klinische Wochenschrift*, Jan. 1, 1938), have described a pancreas stimulating hormone in the anterior lobe of pituitary gland. Injection of the hormone in normal animals is followed by hyperaemia of the pancreas. In cases of acute inflammation of the pancreas blood sugar and diastase contents are raised. Administration of this hormone is found to diminish the blood sugar and diastase values so that necessary intervention on the biliary system can be made early. The hormone has thus proved to be a valuable adjunct in the treatment of the disease.

S. Banerjee.

Bt.-Col. R. N. Chopra

We wish to offer our hearty congratulations to Colonel R. N. Chopra, Director and Professor of Pharmacology, School of Tropical Medicine, on his recent election to the Fellowship of the Royal College of Physicians, England, and to the Honorary Fellowship of the American Society for Pharmacology and Experimental Therapeutics. These two distinctions show the wide interest which the scientific labours of Professor Chopra have evoked in international spheres. By admitting him into the chosen rank of its fellows, the Royal College of Physicians has honoured one of the old members of the College who has signally distinguished himself in the field of Tropical Medicine. The honour that comes to him from across the Atlantic is in recognition of the 'outstanding services to pharmacology' which he has rendered in India, and it is a very important distinction considering that since 1902 only three Honorary Fellows have been elected—Prof. Hans Meyer of Vienna, Prof. Walther Straub of Munich and Sir Henry Dale of London, all of international reputation.

Colonel R. N. Chopra is well known in the medical and scientific circles all over India and needs no fresh introduction to our readers. We are however taking the liberty of appending below a brief life sketch of Colonel Chopra in the hope that his example will stimulate and act as a source of inspiration to the younger generation.

BT. COL. R N. CHOPRA

Born in 1882 in Gujranwalla, a town 40 miles northwest of Lahore, Chopra went, while still a youngster, to stay at Kashmir with his father who was then the foreign secretary to the Kashmir State. After passing the matriculation examination from Kashmir in 1898, he joined the Government College, Lahore, and gradu-

ated in 1902 with science subjects from the Punjab University. The same year, he went to England and started medical studies at the Downing College, Cambridge. In 1905, he passed with honours the Natural Science Tripos of Cambridge and joined the St. Bartholomew's Hospital, London. He obtained his L.R.C.P., M.R.C.S. (Lond.), and the degree of M.B., B.Ch. from Cambridge in 1907. He immediately decided to take up higher studies and to train himself for a career of teaching and research, if possible. English physiology was at the height of its reputation in those days and was attracting students from every part of the globe. Chopra decided to take up that branch of advanced physiology which deals with the action of chemical agents on biological tissues (pharmacology) and entered the laboratories of late Prof. W. E. Dixon, then one of the outstanding figures in English pharmacology. Here he worked for a year and a half and submitted a thesis on "The action of drugs on ciliary movement" which won him the degree of Doctor of Medicine. During the latter part of 1908, he competed for the Indian Medical Service examination and stood third in order of merit. After returning to India in 1909, he served in the Army Medical Corps for 12 years, first in East Africa and then in the Afghan War. When the School of Tropical Medicine was opened in August, 1921, Chopra was appointed Professor of Pharmacology and Physician to the Carmichael Hospital for Tropical Diseases.

His association with teaching and medical research began at this point. As soon as he got the opportunity for research after his career in the Army Medical Corps, he set himself heart and soul to his task. Pharmacology was unknown in India in those days and it was no easy task to organize and equip a laboratory for various types of investigation on the subject. His first paper on the "Therapeutics of Emetine" was published in July, 1922 and was probably the first paper published in India, where the newer pharmacological methods of evaluation of drugs were employed. Since then, a steady stream of researches on various aspects of medicine and therapeutics clinical medicine, tropical medicine, pharmacology, experimental therapeutics, indigenous drugs, drugs of addiction, etc., emanated from that laboratory. Chopra considered, that research in India, at least during the present generation, should concern itself more with 'applied' problems rather than with problems of a 'basic and fundamental' nature. Early in the course of his work, he took up the problem of the Indian indigenous drugs from both their scientific and economic aspects. It is through his work that the attention of the educated public has been focussed on the enormous possibilities that are present in India in this direction and his investigations have given a fillip to the drug-manufacturing industry in India. Space will not permit our going into the details of his many-sided activities. His contributions towards the elucidation of many problems connected with the etiology, pathogenesis and treatment of asthma, lathyrism, epidemic dropsy, dysenteries in India and malaria, however, are quite well known. He is the author of several medical books—*Anthelminics in Medical and Veterinary Practice* published in 1928, *Indigenous Drugs of India* published in 1933 and a *Handbook of Tropical Therapeutics*. In recognition of his work in the field of pharmacology, Chopra was appointed Chairman of the Drugs Enquiry Committee, Government of India in 1931, and his 'Report' is considered to be an authoritative publication on the subject of control and standardization of drugs in the Indian market.

Chopra's ability as a teacher and investigator, his zeal for research and his steadfast application in the cause of medical research began gradually to be recognized in medical and scientific circles all over India. Students were attracted to his laboratory from the different provinces and soon his laboratory became the training ground in India for physiologists and pharmacologists. He was elected a Fellow of practically all the scientific bodies and educational organizations in India including the Royal Asiatic Society of Bengal, the University of Calcutta, the State Medical Faculty of Bengal, the National Institute of Sciences of India and the National Academy of Sciences. In recognition of his services, he was created a C.I.E. in 1933. He was appointed Honorary Physician to His Majesty the King in 1935 and was promoted to the rank of Brevet Colonel. In 1937, the Cambridge University admitted him to the honorary degree of Doctor of Science, a very high distinction, and the Barclay Memorial Medal of the Royal Asiatic Society was awarded to him in 1938. In addition to his duties as the Director and Professor of Pharmacology of the School of Tropical Medicine, Colonel Chopra has been appointed a Director of the new Drug Control Laboratories of the Government of India situated at the All-India Institute of Hygiene. Besides these, Chopra is the officer-in-charge of research enquiries under the Indian Research Fund Association

and the Imperial Council of Agricultural Research. We wish Colonel Chopra many years of a bright and useful career.

—B. Mukerji

Progress of Medicine in the 20th Century

In his article under the above title, Rai Bahadur Dr R. N. Banerjee, M.B., B.S., of Allahabad, describes below, as the name suggests the remarkably rapid advance that medical science has made during the last few decades of the present century. He has, within the space provided, made an excellent survey of the progress of this important branch of human knowledge in all its different aspects. We believe that a perusal of the article will lead the reader to gain a clear idea of the position medicine holds among its sister sciences and also of the extent to which it can alleviate human sufferings today.

The Progress of Medicine in the Twentieth Century

R. N. Banerji

Immense strides have been made in the progress of medical science. In fact, the growth of human knowledge in the domain of medicine has completely overtaken the other branches of sciences in the present century. Formerly, medicine was an art in the domain of philosophers, and disease was understood as an affliction of the body somehow vaguely connected with the soul. But now, with all its recent advances and with the advances of sister sciences, which have been applied to the treatment of disease, medicine can very definitely claim to be called a science in the strictest sense. The transition of medicine from philosophy to science is very interesting. Modern medicine is not even three centuries old. It was only in 1678 that Leeuwenhoek, the father of Bacteriology and Protozoology, constructed what he called his own microscope and saw through it the various "little animals" of disease and described them very accurately in a letter to the Royal Society of London. This opened out two main lines of investigation about the causation of disease, *viz.*, the study of these organisms and their relation to disease. Then came in quick succession the epoch-makers of medical science Bassi and Jenner, Pasteur and Lister, Koch and Loffler, Metchnikoff and Tyndall, to name only a few, and each of them laid the foundation of the previous knowledge of modern medicine. Germs were discovered to be the cause of many of the wellknown infectious diseases, and it was proved beyond doubt that infections cannot grow without these germs, that germs cannot grow without their parents to generate them, that disease was neither vague nor airy but was and is a definite entity having a definite material cause.

It was established that three things were necessary to produce a disease, *viz.*, the host, the germ, and the carrier of the germ from one host to another. They must satisfy Koch's postulates. Based on these foundations, the twentieth-century medical scientists worked out the details and laboured in the direction of discovering specific remedies for specific diseases. This is the way how several specific drugs have been lately discovered in quick succession. Scientists are now fighting with such deadly diseases as cancer and tuberculosis, and it is believed in scientific circles that if these diseases can be produced artificially, their remedies will also be soon forthcoming.

During the era, new conceptions of matter and energy, that have emerged from the experimental physics of the period, have applied themselves to the treatment of diseases. Indeed, the exuberance of the process has certain embarrassing aspects. In the domain of X-rays, phototherapy and artificial sunlight, short-wave-therapy and diathermy, claims have been made and benefits have been proved in cases which are surprising. The use of Radium is another example, thus emphasizing the increasing place in treatment of various forms of Radiant energy, and Electrotherapeutics.

Chemical Processes

Great advancement has been made in the methods of investigating in the production of drugs by complex

chemical processes and in the bio-chemical testing of their effects on animal bodies.

The modern microscope, in contrast to Leeuwenhoek's original microscope, is more ingenious than a modern automobile, magnifying over 1,500 times and so compact and so easy to handle, specially in the binocular variety which saves the straining and squinting of one eye. Similarly, in the domain of drug-chemistry, wonderful synthetic and derivative compounds have been discovered with great therapeutic properties. The physicist, the chemist, the biologist, the physiologist and the clinician are to-day working to discover new remedies for the alleviation of human suffering. This is the most unique feature of the 20th century science of medicine. Today two sets of people are working in the medical line: one is engaged in the laboratory with intricate problems and the investigation and production of remedies, and the other set is chiefly concerned with the practical and timely application of these remedies in curing the sick. If men of genius and brain in every country are engaged at the headquarters in improving the armaments and discovering new weapons to fight disease, there are also in every country highly skilled men who, in the firing line, are laboriously devoting themselves to the treatment and prevention of diseases with these new weapons. However, research seems to be the spirit of the day and the names of Banting, Toplay, Rogers, James, Wilson and many others in France; Fischer (Nobel Prize), Wenkebach, Fredrick, Muller, Aschoff, Romberg, Czerny, Wagner; Jauregg (Nobel Prize), Schick, Smidt, Schulemamn and others in Germany; Von Economo, Landsteiner (Nobel Prize) and others in Vienna; Flexner, Kolmer, Whipple, Minot, Murphy, Zinser, Bayne-Jones and others in America; Noguchi, Shiga, Kobayashi and others in Japan, Wen Cha Ma, Heng, Lew, etc., in China, stand out prominently and are well-known in the medical world. India has also produced some prominent research workers and the names of Brahmachari, Chopra, Rao (Bombay), Das Gupta (School of Tropical Medicine), Charu Bose, Knowles and Napier are fairly well known.

Great manufacturing houses for remedies have sprung up in different countries which are very fully equipped with costly laboratories and learned research workers. They have helped in no small measure the production of modern specialized therapeutic agents. Although they have the commercial motive yet the profession is alive to the help they have rendered to modern medicine.

Tropical Diseases

First the Antimony Tartrate treatment was introduced by Rogers and then in 1920 came the great discovery of Urea Stibamine by Brahmachari. Since then Kala azar has lost its sting. But science has not rested- it has proceeded further and additions to our knowledge have been made regarding its etiology and transmission. In 1924, Napier and Smith proved that the sand-flies are the real transmitter of the disease. Napier's Aldehyde blood test and Chopra's Antimony test by which an early diagnosis of Kala-azar can be made are well known. In the Chinese hamster, a susceptible animal, Kala azar can be artificially produced by the bite of infected sand flies. Brahmachari has also traced out a new skin disease from Kala-azar naming it "Dermal Leishmaniasis." In Germany, a new remedy, Neo-Stibosan, has been manufactured as a second weapon against Kala-azar. Now the market is flooded with imitations of Urea Stibamine, all of them are more or less effective. While in 1910 the death-rate of Kala-azar was 95% and no preventive means were known, in 1935 the death-rate came down below 5%, and to-day we know almost everything about this desease.

Speaking of other tropical diseases we now know that Dengue is caused by a filterable virus transmitted by the bite of certain mosquitoes. We are indebted to Megaw for many a valuable information regarding its causation. Similarly, in the last quarter of a century Typhus and its varieties had been very clearly worked out. We have recently known much about B. Coli fever. This was discovered in 1902 by Dutton and long strides have since been made in its diagnosis and treatment.

The etiology of tropical liver abcess was unsettled up to 1902. It has been proved beyond doubt that Entamoeba Histolytica is the causative factor and treatment by aspiration and emetine is eminently successful. Much work has also been done in the relapsing fevers, in Rat bite fever (Sodoku) caused by the *spirillum minus* which was isolated by Futaki in 1916,

and other spirochaetal diseases specially of the infective jaundice disease group or the icterogenous spirochaetosis disease group, including Weil s disease whose true nature was not known till 1915 when Inadu and Ido found the *Leptospira Icterohaemorrhage*. The history of yellow fever whose existence was known so far back as 1635 is a very interesting reading.

Although so far back as 1926 28, Secllards and others brought forward convincing evidence that the *Lepto-Spiraicteroidis* which Noguchi in 1919 believed to be the cause of the disease is identical with the *Lepto-spira* of infective jaundice, but still conclusive proof is lacking and research workers are busy investigating the problem not only of the epidemiology but also of the prophylaxis of yellow fever. The bacillus of plague, *i.e., bacillus pestis,* was discovered by Yearsin and Kitasato, in 1894; a great deal of work has since been done in India on plague, specially in prophylaxis.

Our knowledge of the dysenteries has been much clarified lately, specially by the Calcutta School of Tropical Medicine, by Acton and Knowles. Emetine was found to cure amoebic dysentery in most cases. But a sort of chronic infection generally persisted; several drugs have since been discovered for this condition. Chopra declared that the Indian Kurchi is very good for this; later Stovarsal and other arsenical preparations came into use and the latest thing in the line is Carbarsone which is claimed by Chopra to be the best of the whole lot so far, discovered. Amoebiarson is very similar to Carbarsone. It is interesting to note that only in 1908 Schaudin differentiated the Entaemebae Hystolitica from the harmless Entamoeba Coli with which it has formerly been confused and although Ipecacuanha was long used in drugs, it was only in 1912 that Sir Leonard Rogers demonstrated the specific action of the injections of their active principle, *i.e.,* emetine in amoebic dysenteries. Speaking of cholera, which was probably known to Susruta in India in the 7th century, its causative organism, the coma bacillus of cholera vibrio was discovered by Koch, a German, in Egypt, in 1883. Since then a great deal of research has been done to combat the disease and we have today satisfactory prophylactic measures and methods of treatment including intravenous injection of hypertonic and alkaline saline. The latest research work with the treatment of cholera is being done with Bacteriophages of suitable types. Similarly in leprosy, in filariasis, in Beriberi and in most other important tropical diseases great advances have been made the recounting of which will unnecessarily lengthen the article, but we shall say a word about leprosy and filariasis.

Bacteriophage

The discovery of Bacteriophage by D' Herelle is a noteworthy fact. No one ever knew before that there are existing in our world such friends as the ultra-bacteria or organisms even smaller than the bacteria that can devour their progenitors, disease producing bacteria themselves. D' Herelle, a French Canadian scientist, came to India in 1928 on a commission from the British Government to make investigations regarding cholera and while examining water from the Jumna discovered the presence of the ultra-microscopic beings. He found them living side by side with the cholera germs and later discovered that wherever there were bacteria in nature, there were co-existing appropriate bacteriophages that could conveniently devour them and hence they are enemies of our enemies in nature. These becteriophages are specific against their particular bacteria and can be cultured and used mainly for the treatment and prevention of several bowel diseases. Bacteriophages are now being given an extensive trial at Puri and other places in India and are also being used in the treatment of cholera whose successful prevention by the inoculation of cholera vaccine since the Great War has brought down the mortality rate from 60 to 20 p.c.

Leprosy Cure

Leprosy is now being cured fairly successfully. One cannot now say that a man is doomed for ever, suffering from leprosy, because he is a leper. Many startling facts have been known regarding this horrible ailment. The disease is not very contagious and is not at all so during its late breaking-down stage that we generally find in street beggars. The treatment of this disease on scientific lines was first started by Rogers in 1915 when in collaboration with the late Dr C. L. Bose, he prepared sodium gynocardate from chalmugra. Later on, Muir taking up the thread discovered the new Hydrocreol in 1925 and to him we owe much for the several recent advancements in

leprosy. Research is going on in filariasis although definite results have not yet been reached. The British Guiana Filariasis Commission of 1921 reported that *Streptococci* join with the filaria to produce the disease and if they are checked the condition of filariasis would be cured although the filaria might still persist. Since then the strepteoccus vaccine is being extensively used.

In the successful treatment of hook-worm by Carbon Tetra Chloride, new ground has been gained. Coming to the general discoveries, the new discovery for the treatment of diabetes, *i.e.*, Insulin, is worth mentioning first. In 1923 Banting and McLeod found out this remedy, Insulin, from animal pancreas and were awarded the Nobel Prize for their great discovery.

The whole group of vitamins form another big chapter of medical research and their history would take a greater space than is available here. Suffice it to say that their number has reached the alphabet G and the first five are extremely important to us, in health and disease. (*Vide* Sc. & Cul., 3, 631-3? 1938).

The next wonderful discovery is the treatment of pernicious anaemia by administering liver substance, found out by Whipple, Minot and Murphy in 1926. No one could cure this terrible decaying illness previously. The condition is often found in pregnant mothers, and liver treatment has been found very successful.

Liver Extracts are now available as injections and are effective in other forms of anaemia also. They are successfully employed in the treatment of sprue, haemo-phillia, tuberculosis, epidemic dropsy, and even smallpox. The discoverers were awarded the Nobel Prize in 1935.

The treatment by producing artificial pnemothorax by introducing gas into pleural cavity of the affected side and thereby collapsing the lungs, and giving it a period of rest has been very successful in cases of unilateral phthisis as several permanent cures have been effected by this method. The other efficacious treatment of this fell disease by repeated injections of calcium, of gold (solganol), etc., has been coming into greater practice during this period.

Every one is aware that a new epoch has been started in the treatment of syphilis, since 1910, when the great Ehrlich and Hata discovered salvarsan as a result of their lifelong researches and after 605 previous experiments had failed. Subsequently newer products like Neosalvarson, Novarsen-obillon, Neoars-fenamin, solfarsenol were brought out and they are now universally used. Recently, Brahmachari in India has brought out a similar product by the name of Thiosarmine which has been well reported on by the Calcutta Hospitals. Bismuth has been used conjointly to effect a permanent cure. An enquiry into the treatment in syphilis was carried out in 5 countries under the auspices of League of Nations and they, after collecting a very large amount of facts and figures and clinical data from all the great syphilologists from all over the world, have very carefully laid down plans for the radical cure by the intermittent and continuous treatment of syphilis at its different stages and their report is regarded today as the last word in the treatment of syphilis.

In the domain of Endocrinology and Organotherapy, a new branch of modern medicine has been opened out. The functions of the internal glands are being determined, their hormones studied and eventually they are used therapeutically. Sometimes their effects are miraculous. The effective use of Adrenaline, Pituitrin, Thyroid and Para-thyroid are well-known to everybody. One hopes that endocrine therapy may become more precise in future and that there will be reliable tests to know when a particular gland or glands are not acting sufficiently well. The developments in the field of research regarding the sexhormones have been very rapid, indeed, during the last few years.

Ascheim, and Zondeck discovered that oestrin was excreted in the urine during pregnancy. And the reaction for pregnancy that goes by their name, offers a sure test of pregnancy from the 6th week onward, corresponding with the date of the formation of placenta. This test depends upon the fact that the urine of pregnant women countains a substance which induces the formation of haemorrhagic follicles in the ovary of the sexually immature mouse. By this test pregegancy may be diagnosed as early as the first week after the first missed period.

Biochemistry

Another department of medical investigation of recent origin is bio-chemistry. Bio-chemistry is no longer merely the handmaiden of physiology. It is a

study of the normal living being, of the nature of the chemical and biological processes therein whereby the potential energy of its food is converted into work and heat. It takes into account the "wear and tear" of the organism itself and includes in its study the chemical disintegration of the organism and its repairs. A great bulk of modern research relates to the advance in biochemistry and the work in the laboratories, about the technique of certain tests and investigations of the chemical changes that the body fluids and secretions undergo in health and disease.

Folin, Benedict, Meyers, Fine and several other American scientists are the pioneers in this line of work. By their methods it can be found out, from a small quantity of blood, what the exact percentage of its sugar content is, how much waste nitrogen is accumulated in it, what the amount of blood urea is , or the amount of chlorides of calcium, of phosphorous etc., in the blood of a sufferer. The study of these helps us clinically to understand the exact condition of the patient. It is well known that these tests are of great clinical value in disease like diabetes, gout, tetany, nephritis, hepatitis, etc.

Mental Disease

A great deal of improvement has been effected in the treatment of mental diseases. Wonderful drugs have been discovered that can quickly quieten the irritated brain. Their differentiation and correct diagnosis have received due attention. The new method of treatment of mental conditions by keeping the patient in a hot-water bath for several hours has proved quite effective, and there are said to be arrangements for such baths at Ranchi.

Surgery

The improvements in surgery have been marvellous. The technique has become a fine art. The results are wonderful. Surgeons today can perform operations on the brain and heart without much hesitation. Anasthesia both local and general has vastly improved.

Novocain, Evipan-sodium and a host of others have come into everyday use and the old fashioned chloroform is gradually passing out.

It is due to the admirable genius of Dr Bohler of Vienna that most of the new development in orthopoedic surgery has been made.

Formerly a fracture was invariably tied to a splint for a prolonged period. But now with the use of extension, treatment is not so vigorous and the limb does not get stiff. In the last Great War, surgery made great advances and the technique today leaves very little room for improvement. Another noteworthy discovery in surgery since 1925 is on the treatment of burns with 2.5 p. c. tannic acid solution which can cure extensive burns in a fortnight.

Midwifery

In midwifery too, there is much worth recording. The Stroganoff's treatment for eclampsia, and the modern treatment of pregnancy toxamias are really successful. The operation for opening the womb through lower-segment caesarian section has become devoid of all risks. Antinatal clinics are trying to decrease the infant mortality rates. Maternity work has drawn the attention of the League of Nations and in every civilized country Maternity and Child Welfare Clinics have sprung up.

Bacteriology

In Bacteriology the developments are enormous. In this short paper it is impossible to mention any name in detail. Discoveries of new bacteria are innumerable, as also of vaccines and sera against these. During this century, the regular use of improved sera and vaccine have become universal. Lately, Bacteriology has been busy with ultra-microscopic and filterable viruses that produce diseases like common cold, measles, smallpox, yellow fever, etc.

Besides, researches are being carried on with the anaerobic bacteria like those that produce gas-gangrene, and the anti-gas-gangrene serum is being used for gangrene and several acute abdominal diseases. The culturing of bacteria and bacteriophages are really becoming things of the past. The latest development is the culture of living animal tissue within the Incubator. Embryonic tissues (such as little bits of hard liver, eyes, etc., cut out from chicken embryos of freshly hatched eggs or of embryos from the womb of a rat) are planted on slides with aseptic precautions, supplied with embryonic extracts for nutrition, and are incubated and kept alive for several days. Thus a portion of the heart can be kept alive up to 80 days with its natural

processes of growth and movement going on. In the Incubator microscope, the cells can be seen multiplying by the natural process of mitotic division and each cell can be actually seen throbbing in coordination with the others. This tissue culture has a special significance as a means to detect action of drugs or poisons of diseases on living tissues under the very eyes; and specially for experiment with ultramicroscopic disease virus. This work has lately been started in the Calcutta School of Tropical Medicine and they are working at present with materials from cases of epidemic dropsy to find their actual influence on living tissue. It is not time yet to say anything definite about the real cause of epidemic dropsy, but that there is something in the blood and tissue fluids of these cases that can markedly influence the healthy living tissue is quite evident from these experiments. Further developments are being eagerly awaited.

X-Rays

The apparatus has been greatly improved with the Potter Bucky diaphragm; a new device has been obtained by which images of internal structures can be more distinct. Radiography has become very clear with the use of bismuth meals and certain dyes for soft tissues.

I need not dilate on Radium, Ultra Violet Ray and short wave diathermy about all of which I have already mentioned, but I must now refer to Electrocardiography, a new invention of this period.

Electrocardiography

In 1903 Einthoven discovered it and since 1910 it is being used in England. This delicate instrument, by recording the changes in the potential of the heart muscles and by recording the course of the cardiac impulse in the heart, can trace the minute electrical changes of the cardiac muscles at each movement, so that not only every heart disease can be diagnosed correctly and early but a very correct prognosis can be made and the effects of treatment can be properly assessed.

This is only a brief outline of the modern advances in the different branches of the great science of Medicine, which only indicates how the soldiers of the medical world are proceeding in triumphant march to conquer the enemies of the human body. We may now conclude by quoting the same words that Sophocles had uttered more than 2000 years ago

"Of all the wonders of the world there is none more wonderful than man. He holds sway over the denizens of the air, earth and sea, and fears no longer the surge of the elemental forces of nature. Of thought and speech too he has made himself master. Death alone he cannot avoid; yet he may postpone it, for has not his skill devised many a remedy against the direst of diseases?"

RESEARCH NOTES

Electron Transfer during Muscular Contraction

It is known that ultimately the energy for the contractile process of muscles is derived in preference from the combustion of carbohydrate. The basic feature in the combustion of carbohydrate is the transfer of electrons or hydrogen atoms from hexose phosphate to the pyridine ring of the aerobic Co-ferment triphosphopyridine nucleotide, and to the anaerobic Co-ferment diphosphopyridine nucleotide, Co-zymase. These nucleotides transfer the electrons to yellow ferment, flavoprotein, and also to cytocrome C. Urban and Peugnet concluded that yellow ferment and cytochrome are associated with some phase of muscular contraction, since they are formed in muscle, and since they would be expected to have direct access to the energy supplied by carbohydrate.

Keilin, from spectroscopic observations postulated a correlation between cytochromes and muscular activity. He also established a correlation between the cytochrome content of muscle and the ability of this muscle to perform work.

The cytochromes, and yellow ferment, are active by electron transfer, or oxidation reduction, showing a change in the absorption spectrum during the process. Yellow ferment becomes oxidized by giving off electrons and this transfer is accompanied by the appearance of an absorption band at 465 mμ. On the other hand, the reduction of cytochrome C results in the appearance of a strong absorption band at 549 mμ.

If then a material under observation be illuminated with monochromatic light the wavelength of which corresponds to that of a specific absorption band, changes of intensity of the transmitted light may, with suitable controls, be interpreted in terms of changes of concentration of the absorbing compound.

Frank Urban and H. B. Peugnet [*Proc. Roy. Soc.*, **B.** *125*, 93, 1938] describe an apparatus by which they have recorded instantaneous changes in the absorption spectrum of muscle.

Muscles (gastrocnemii of Rana pipiens) were illuminated with light of wavelength 465 mμ, the muscle being held between parallel glass plates, to prevent any change in thickness during contraction. The light, issuing from a slit, traverses the muscle at right angles. A photocell, connected through a condenser-coupled amplifier to a cathode-ray oscillograph, instantly records any change in the intensity of this light. A decrease indicates appearance of oxidized yellow ferment. When the wavelength of the light is 549 mμ instead of 465mμ, then a decrease in intensity would indicate the appearance of reduced cytochrome C. The deflexion, controlled by the photocell, of the cathode-ray beam from its straight path, as it sweeps horizontally across the face of the tube, is termed a chemical analysis *in situ*, during contraction.

The records were all taken in a dark room. By means of the apparatus described in detail by the authors they have shown that yellow ferment and Cytochrome C are active during the aerobic contraction phase of a gastrocnemius muscle.

These findings will prove to be very significant for the explanation of the mechanism of muscular contraction.

H. N. B.

Antiplasmodial Action and Chemical Constitution

The cinchona alkaloids are of known constitution, but little is known as to why they are antiplasmodial in action. The introduction of experimental bird malaria has given a means of following changes in therapeutic activity with changes in chemical structure. Some insight has already been gained

of the effect of simple changes of structure of the cinchona alkaloids on their antiplasmodial action in bird malaria. Cohen and King [*Proc. Roy. Soc.*, **B**. *125*, 49, 1938] have furnished additional data which might provide a working hypothesis for further experiments on the subject.

All the cinchona alkaloids are more or less antiplasmodial. As there are considerable stereochemical differences between the various cinchona alkaloids it follows that antiplasmodial action is not very sensitive to such stereochemical changes. It is however sensitive to changes in structure, and the most striking result observed by the authors is the apparent loss of activity when the central CHOH– –group is modified in any way. Thus its alteration by conversion into—CHCl—,—CH_2—or—CH=leads in almost all cases to an increase in toxicity and loss of antiplasmodial action. It is possible that the —CHOH group acts as an anchoring group on certain structures in the parasitic substance and thus takes part in the mechanism of destruction of the parasite.

If the—CHOH—group is kept intact activity may be retained with some change in structure. When the vinyl group is oxidized to carboxyl, quitenine is formed which is inactive. This is to be expected, since its distribution in the tissues will be quite different from that of a base, and this is confirmed by the fact that on esterification and restoration of basic properties activity reappears. It is however very surprising to find that conversion of the ester group into an amide group results in apparent loss of activity.

By further experiment on bird malaria due to *Plasmodium relictum* in canaries the authors find that quinicine, the ketonic isomeride of quinine is inactive, and that reformation of a carbinol group by reduction does not restore activity. **α-*N*-methyldihydroquinicinol is also inactive. This led the authors to synthesize 4-quinolyl-α-piperidylcarbinol and 4-(6-methoxyquinolyl)-α-piperidylcarbinol and their *N*-methyl, *N*-propyl, *N*-allyl, *N*-butyl and *N*-crotyl derivatives. The only compounds obtained showing antiplasmodial activity were the second compound and its diastereoisomeride *iso*-4(6-methoxyquinolyl)-α-piperidylcarbinol.**

These two methoxy bases with antiplasmodial activity appear to be the first compounds to be synthesized on the pattern of the quinine molecule which show any activity in bird malaria.

—*H. N. B.*

Theory of Order for the Copper Gold Alloy System

[W. Shockley, *Jour. Chem. Phys.*, March 1938]. **The theory of order and disorder, in the form used by Bragg and Williams, is extended to arbitrary composition of the constituent elements. The work is based upon the nearest neighbour interaction assumption of Bethe and the connection between the Bethe and Bragg-Williams theory is shown. In order to extend the Bragg-Williams theory to compositions other than 25 and 50 atomic per cent, new definitions of order are developed. The results are presented in terms of phase diagrams and curves showing energy *vs.* temperature, specific heat *vs.* temperature and state order *vs.* temperature. These results are of importance in giving a general picture of the order-disorder transformation for a wide composition range. They are not in detailed accord with experiment due to the rather idealized picture underlying the nearest neighbour assumption. (Abstract from *Bell Sys. Tech. Jour.*)**

UNIVERSITY AND ACADEMY NEWS

Royal Asiatic Society of Bengal

An Ordinary Monthly Meeting of the Royal Asiatic Society of Bengal was held on Monday, the 6th June, 1938, at 5-30 p.m.

The following candidates were balloted for as Ordinary Members:—

(1) Naba Kumar Singh Dudhoria, Azimganj, Dt. Murshidabad.

(2) Clement Webb Tressler, M.A. (Allahabad), Senior Professor of History and Political Science, Murray College, Sialkot, Punjab.

(3) Allard Merens, Netherlands Consul-General, Calcutta.

The following papers were read:—

1. C. C. Das Gupta. A type of sedentary game prevalent in the United Provinces of Agra and Oudh.

2. Miss Mary Chandy.—The Histology and Physiology of the Intestine and Hepato-pancreas of two Isopods, *Ligia exotica Roux* and *Armadillio elevatus* Verhoeff.

The following exhibit was shown and commented upon:—

1. M. Mahfuz-ul Haq.—A note on a Persian Manuscript of Saha'if-i-Shara'if of Muhammad Askari al-Husaini of Bilgram.

The manuscript, which comprises the biographical sketches of the Persian prose-writers of India and Iran, has recently been acquired by the Royal Asiatic Society of Bengal.

The manuscript is apparently unique as no other copy is known to exist in any well-known library. A feature of the manuscript is that it is the author's autograph copy.

The author, Saiyyid Muhammad 'Askari bin Saiyyid Khurshid Ali,' was born at Bilgam. He was a talented Persian scholar and poet of his age. He composed the Saha'if in 1213 A.H. (1815-16 A.D.). It contains valuable data regarding the Persian prose-writers in general and the contemporary Indian writers in particular. There are several interesting specimens of the compositions of the Mughal kings, princes and princesses.

The following communication was made:

Chintaharan Chakravarti, Kasinatha Bhatta—a polymath.

A fairly large number of small treatises, principally on Purana or Tantra topics, ascribed to one Kasinatha Bhatta Bhada of Benares, alias Sivanandanatha, are available in manuscripts in different parts of India. But very few of these works have been brought to the notice of scholars either through descriptive notes or through print. Little again is known about the author. So an attempt has been made to collect an account of these works as well as of the author so far as could be gathered from a survey of them, mainly on the basis of the manuscripts of a large number of Kasinatha's little-known works, belonging to the Royal Asiatic Society of Bengal.

University of Bombay

The Registrar of the University of Bombay has invited applications for the appointment of the Ranchhoddas Tribhovandas Mody Professor of Chemical Technology and Head of the Department of Chemical Technology on a salary of Rs. 800—50—1,000. In making the selection, other things being equal, preference will be given to an Indian. Full particulars of this appointment have been given in the advertising pages of this issue.

Letters to the Editor

[*The Editor is not responsible for the views expressed in the letters.*]

On Magnetic Anisotropy of Crystals in Relation to Crystalline Structure

In the critical torsion method of Krishnan and others for determining magnetic anisotropy, critical rotation occurs at 45° deflection of the crystal only when the torsional constant is very small compared to the magnetic force on the crystal. This holds true for moderately thin suspension, when the crystals are large and highly anisotropic. For crystals of feeble anisotropy and also for substances of which only very very small crystals are available, this approximation does not hold true, but the relation between α_c, the angle of rotation of the torsion head at critical rotation, and $\Delta\chi$ is given by the φ_c eliminant of the equations

$$C + 2B\,\Delta\chi \sin 2\varphi = 0$$

$$\text{and } 2\varphi_c - \tan 2\varphi_c = 2\alpha_c$$

where φ_c is the critical angle of rotation and $B = mH^2/2M$, φ_c is easily obtained from α_c by plotting graphically the relation $2\varphi - \tan 2\varphi = 2\alpha$.

The following table gives the results of measurements on the crystals investigated and the conclusions arrived at. Very thin quartz fibres (torsion constant = .003 nearly) and magnetic field of about 37 kilogauss between plane pole-pieces of area 100 sq. cm. were used.

Substance.	*Axis of suspension.*	*Orientation in the field.*	$\Delta\chi \times 10^6$	*Conclusion.*
Artostenone $C_{30}H_{50}O$.	a vertical	c normal to the field	7.53	The mean planes of the closed rings make 65° with the ab plane; 35° with the c-axis.
	b—vertical	c at 55° to the field	3.61	
	c—vertical	b along field	11.42	
Guanidine carbonate $CNH(NH_2)_2, H_2CO_3$	c-face vertical	c axis along field	1.42	The oxygen triangle is parallel to the c-axis and the two-fold axis of molecular symmetry bisects the angle between a & b axes.
O—dinitrobenzene $C_6H_4(NO_2)_2$	a-vertical	c normal to the field	44.36	Plane of benzene ring nearly parallel to c face.
	b—vertical	c makes 68° with the field.	48.29	
	c—vertical	b along field	8.54	
m—dinitrobenzene $C_6H_4(NO_2)_2$	a—vertical	c normal to field	49.80	Benzene plane parallel to the a axis and inclined to the b by 22° 20′.
	b—vertical	c normal to field	59.92	
	c—vertical	a along field	10.25	
Benzamide $C_6H_5CONH_2$	102 face horizontal	b normal to field	13.98	Benzene ring makes 44° 32′ with the c-axis, 46° 6′ with the a-axis.
	102 face vertical & b horizontal.	b along field	12.97	
	b—vertical	102 face at 71° to the field.	34.7	

LETTERS TO THE EDITOR

The results on artostenone indicate that the method will be very fruitful for investigation on compounds of biological origin. Work on other such compounds is in progress.

K. Banerjee.
J. Bhattacharjya.

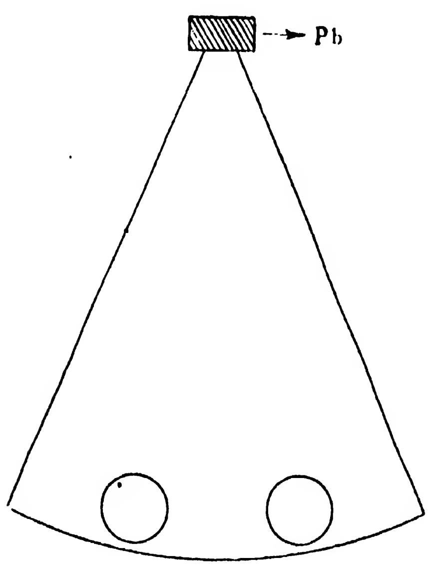
Physics Laboratory,
Dacca University.

Angular Distribution of Electron Pairs

Geiger[1] and Funfer gave a systematic analysis of the cosmic rays. They assumed primary cosmic rays to be mostly heavy, positively charged particles which successively produce γ quanta, electron pairs (electron and positron), photo-electrons and Compton electrons by interaction with matter. The whole group of these rays are in one word termed showers, which were beautifully shown in the Wilson Chamber photographs taken by Blackett[2] and others. By an analysis of these photographs Anderson discovered the existence of positron a positively charged particle of electronic mass.

This experiment was undertaken to find out the angular distribution of electron-pairs or the "C" rays according to Geiger's scheme at two different altitudes one at Calcutta and the other at Darjeeling, 70 ft and 7100 ft in height respectively above the sea-level.

Two Geiger-counters were placed in an arc of a circle of 1 metre radius and the Pb plates were placed on a plate at the centre of the arc of that circle. The angle was varied by changing the distance between the counters.



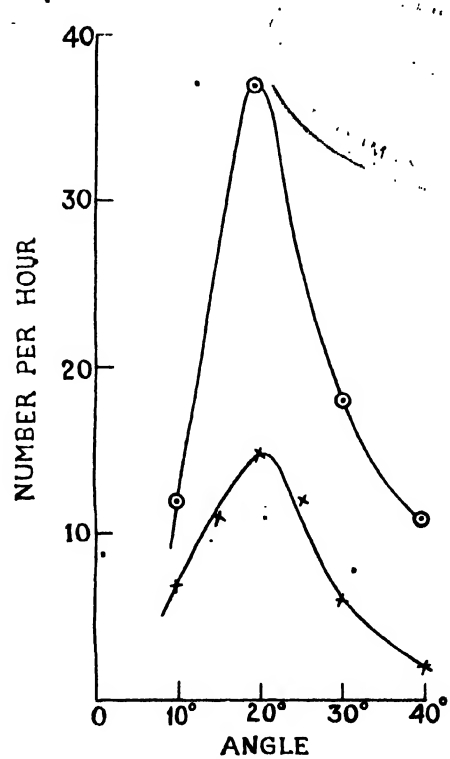
The dimension of the Pb plates, used at Darjeeling, is 25 cm. in length, 3 cm. in breadth and 1.65 cm. in thickness. Due to the low intensity of the shower-producing radiations in cosmic rays at Calcutta, no measurements could be made with Pb plates of above dimensions. The dimensions of Pb plates used at Calcutta were 30 cm. in length, 20 cm. in breadth, and 1.65 cm. in thickness.

Results at Darjeeling:

Angle between the electron pairs.	*No. of counts with Pb plates in 1 hr.*	*No. of counts without Pb plates in 1 hr.*	*Difference.*
10°	66	54	12
20°	72	35	37
30°	55	37	18
40°	28	21	7

Results at Calcutta:

10°	28	21	7
15°	21	10	11
20°	21	6	15
25°	19	7	12
30°	12	6	6
40°	9	7	2



The advantage of taking two tube coincidences in this experiment is that no geometrical correction is necessary.

LETTERS TO THE EDITOR

The natural effect which arises due to two tube coincidences is always subtracted by taking the readings without Pb plates. In the case of the shorter angles more natural effect is counted. That is due to the effect of the coplanar rays, which become more prominent at shorter angles due to relatively smaller distance between the counters.

The results at Calcutta and at Darjeeling show a definite maximum at 20°, *i.e.*, the electron pairs or the "C" rays according to Geiger's scheme form an angle of 20° with each other. From the curve it is found that at higher altitudes more divergent rays become more prominent in intensity than those at lower altitudes.

Held[4] carried out this experiment and found the maximum at about 20°, Puschel[5] at 10°. Hu Chien Shan[6] found that the smaller the angle the greater is the intensity of showers. Geiger[7] and Zeiller and Auger[8] and Ehrenfest found the space distribution of the cosmic-ray showers to be at its maximum at 20° and 18° respectively to the direction of the principal rays. Bothe[9] delivered a lecture in the last Indian Science Congress and communicated that for 1.65 cm. thickness of Pb the shower intensity decreases in the order of the angle 28°, 7°, and 4°, while for the hard shower-producing rays the intensity of the showers is in the reverse order. We find in this experiment also that for 1.65 cm. thickness of Pb the intensity at 28° is greater than that at 7° or 4° if the curves be extrapolated.

The results of Darjeeling were read in a meeting of the Indian Physical Society in 1936.

The author is grateful to the authorities of the Bose Research Institute for granting him a scholarship and for providing him with all facilities to work in the Institute.

Bose Research Institute, Calcutta. 5-5-38. Radhesh Chandra Ghosh.

[1] Geiger and Funfer *Zs. f. Phys.*, *93*, 543, 1935.

[2] Blackett and Occhialini *Proc. Roy. Soc., Lond.*, **A**, *139*, 699, 1933.

[3] Anderson—*Phys. Rev.*, *41*, 405, 1932; *44*, 406, 1933.

[4] W. Held— not published.

[5] B. Puschel *Phys. Zs.*, *37*, 661, 1936.

[6] Hu Chien Shan—*Proc. Roy Soc., Lond.*, **A**, *158*, 581, 1937.

[7] Geiger and Zeiller—*Zs. f. Phys.*, *105*, 517, 1937.

[8] Auger and Ehrenfest—*J. de Physique et le Radium*, *7*, 473, 1936.

[9] W. Bothe Communicated to the *Ind. Jour. Phys.*

On the North-South Asymmetry of Cosmic Rays

The experiments by the method of multiple counter coincidence carried out by Johnson[1] in Mexico (Geomagnetic Latitude 29° N) and by Clay[2] in Java (Geomagnetic Latitude 18° S) have shown that in the northern hemisphere the intensity of the Cosmic Rays in Geomagnetic Meridian is, for equal zenith angles, greater from the south than from the north; conversely in the southern hemisphere it is greater from the north than from the south. That this is a consequence of the earth's magnetic field on the motion of the charged electrical particles was pointed out by Le Maitre[3] and Vallarta as early as 1932. Shortly afterwards Bouckaert[4] was able to calculate this north-south asymmetry for geomagnetic latitudes up to 20° and for moderate zenith angles. Starting from the assumption of isotropic distribution of electrically charged particles at a very large distance from the earth, it is found that, due to the influence of the earth's magnetic field, some of these particles are shot back to infinity, while others are allowed to reach the earth. It is shown that at any point, at a given distance from the earth's magnetic centre all paricles of a given energy reaching the earth must come within a cone generally of a very involved shape, which forms the boundary between the region in which only some or no directions are allowed. With the help of very elaborate analysis, the results obtained by Le Maitre and Vallarta have been embodied in the form of curves drawn for different magnetic latitudes which give the least energies required of a particle expressed in units *milliströmer*) to arrive at any point on the earth up to latitude 40°. It is found that these values are not the same for same north-south zenith angles corresponding to a given magnetic latitude and hence a north-south asymmetry arises. This asymmetry is however irrespective of the sign of the charged particles. It is found that the minimum of the north-south asymmetry as well as the general feature of the experimental results of Johnson are fully accounted for by the earth's magnetic field. According to these authors, further experimental study of this asymmetry will provide with a direct workable method for the analysis of the spectral distribution of the corpuscular cosmic radiation independent of its charge.

The previous experiment of the author[5] carried out at Calcutta and at Darjeeling shows that the asymmetry increases with altitudes. But at no stations a point of dip, *i.e.*, the intensity from the south equalizing with that from the north as observed by Johnson, was found. The readings in that experiment were taken at larger angular intervals. This experiment was carried out at Darjeeling with shorter angular intervals in order to find out the angle of dip if that exists. The latitude of Darjeeling is 27° N, altitude 7100 ft.

The experiment was carried out with three Geiger-counters by the method of coincidence. The counters were placed in a vertical rotating bench which could be tilted to any zenith angle when the bench was placed in a direction vertical to the magnetic meridian. The amplifier used was of Bothe's type.

MEAN RESULTS OF THE READINGS

Angle against the vertical.	*Number of counts per minute.*
0°	2.62
15° South	2.12

15° North	2.13
30° South	1.78
30° North	1.56
45° South	1.46
45° North	1.21
60° South	0.95
60° North	0.61

The results show that the intensity from the south predominates over that from the north which agrees quite well with the calculations of Le Maitre and Vallarta as well as with the experiment of Johnson. But the point of dip as found by Johnson at a particular angle could not be found even with an angular interval of 15°. If the point of dip exists at all, the angular definition between the counters should be made too defined to detect.

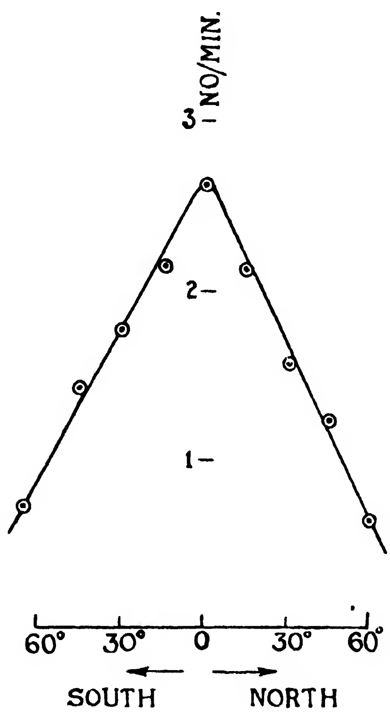


Fig. 1

The author is grateful to the authorities of the Bose Research Institute for granting him a scholarship and providing him with all facilities to work in the Institute.

Bose Research Institute, Calcutta.
5-5-38.

Radhesh Chandra Ghosh.

[1] Johnson—*Phys. Rev.*, *47*, 91, 1935.
[2] Clay—*Physica*, *8*, 867, 1935.
[3] LeMaitre and Vallarta—*Phys. Rev.*, *43*, 87, 1933. *Phys. Rev.* *42*, 914, 1932. *Phys. Rev.*, *49*, 719, 1936.
[4] Bouckaert—*Ann. de la Soc. Sci. de Brussells*, **A**, *54*, 174, 1934.
[5] Ghosh—*Trans. of the Bose Res. Inst.*, *11*, 1936-37.

Vitamins B_1 and B_2 Content of a few common Preparations of Rice

Bengal is predominantly a rice-producing province, and naturally the people of Bengal have discovered various methods for the utilization of this cereal in their daily dietary. Besides boiled rice, which forms the basis of their principal meals, they prepare *Chira* or flattened rice. The rural population takes this stuff along with molasses or with molasses and milk as the case may be. *Muri* (parboiled rice, fried on sand bath) and *Khai* (paddy, fried on sand bath) are the two other favourite supplementary articles of dietary used in the countryside. In big towns these cheap preparations of rice are gradually being supplanted by tea and biscuits.

As apart from the actual symptoms of beri-beri various other affections owe their origin at least partially to the lack of B-vitamins in the system, it was thought worthwhile to investigate the "vitamin B" content of these indigenous articles of dietary.

For the estimation of vitamins B_1 and B_2, the biological method of assay with young albino rats, as modified by Guha and Chakravorty,[1] was followed.

In the following experiments 5 rats of each group, deficient in vitamins B_1 and B_2 respectively were put on 2 grams of the experimental substance daily for a period of 3 weeks and the average weekly gain in weight in grammes was determined.

1 (*a*) The feeding of the country made brown *Chira* from a coarse variety of *Aman* paddy to the B_1 and B_2 deficient rats produced average weekly gains in weight of 6.9 g. and 3.7 g. respectively; or 100 g. of the brown *Chira* contained 34.5 units of B_1 and 18.5 units of B_2 (as defined by Guha and Chakravorty[2]).

1 (*b*) When fine *Chira* (procured from the Calcutta market) was fed, in the above-mentioned way the average weekly gains in weight of the B_1 and B_2-deficient rats were found to be 4.5 g. and 2.5 g. respectively, or 100 g. of the substance contained 22.5 units of B_1 and 12.5 units of B_2.

2. The feeding of *Muri* by usual process gave 2.9 g. and 2.2 g. of average weekly gain in weight in the B_1- and B_2-deficient rats respectively, or 100 g. *Muri* contained 14.5 units of B_1 and 11 units of B_2.

3. The feeding of *Khai* in the above-mentioned way, produced an average weekly gain in weight of 2.6 g. and

2.8 g. in the B_1- and B_2-deficient rats respectively, or 100 g. *Khai* contained 13 units of vitamin B_1 and 14 units of vitamin B_2.

From these experiments it is clear that *Chira*, particularly the brown variety of the countryside, is a good source of vitamin B_1 and it is also a fair source of vitamin B_2. *Muri* and *Khai* come next and fall almost under the same category in respect of their vitamin B_1- and B_2-content.

My sincere thanks are due to the authorities of the firm for their constant help and encouragement in this work.

Biochemical Laboratory, Bengal Chemical & Pharmaceutical Works, Ld., Calcutta. 21-5-38.

H. G. Biswas.

[1] *Ind. Jour. Med. Res.*, *20*, 1045.

[2] *Ibid.*, *21*, 221.

A New Method for the Synthesis of Coumarins

Resacetophenone condensed with bromacetic ester in the presence of zinc (Reformatsky) giving the hydroxy-ester, which, on dehydration with phosphorus oxychloride, and subsequent ring-closure gave 7-hydroxy-4-methyl coumarin. Similarly by using ethyl bromo-propionate, we obtained 7-hydroxy-3:4 dimethyl-coumarin. Our idea was to apply this method for the synthesis of 7 hydroxy-4:5-dimethyl-coumarin from orsacetophenone and bromacetic ester, but the work has been delayed as our stock of orcinol is exhausted. We have been compelled to publish this note as we have been forestalled by Chakravarti and Majumdar.[1] This method promises to be useful for those coumarins which cannot be obtained by the usual Pechmann's reaction. Full details will be published elsewhere.

Department of Chemistry, Muslim University, Aligarh. 15-6-38.

R. D. Desai.
M. Ekhlas.

[1] *J. Ind. Chem. Soc.*, *15*, 136, 1938.

Synthesis of Coumarins from O-Hydroxy-aryl alkyl ketones

In attempting to synthesize naturally occurring coumarins by the method described by the authors[1] it has been found that

(*i*) When there are two alkyl substituents namely in the α- and β-positions of the expected cinnamic acid, *cis*-cinnamic acid is formed and the coumarin is obtained in quantitative yield;

(*ii*) When there is no substituent in the α-and β-positions of the expected cinnamic acid, *trans*-cinnamic acid is formed and ring closure does not take place forming coumarin;

(*iii*) When there is only one substituent in the α-position of the expected cinnamic acid, *trans*-cinnamic acid is formed and the coumarin is not formed by ring closure.

Thus *o*-methoxy-benzaldehyde condenses with ethyl bromoacetate giving ethyl 2-methoxy—*trans*-cinnamate (b.p. 150°/8 mm.), which on hydrolysis yields 2-methoxy—*trans*-cinnamic acid (m.p. 182°), identical with the compound prepared from an authentic specimen of *o*-coumaric acid. Similarly *o* methoxy-benzaldehyde and ethyl α-bromo-propionate yield ethyl 2 methoxy- α-methyl cinnamate (b.p. 155°/4 mm) which on hydrolysis produces the acid, *trans* 2 methoxy—α methyl-cinnamic acid (m.p. 104°), identical with the compound described by Perkin.[2] β-Resorcylaldehyde-dimethyl-ether and ethyl bromoacetate gives ethyl 2:4-dimethoxy-- *trans*-cinnamate (b.p. 184°/8 mm.) which on hydrolysis furnishes 2:4-dimethoxy—*trans*-cinnamic acid (m.p. 184°) of Perkin and Schiess.[3]

It is interesting to note that ethyl 2-methoxy *trans*-cinnamate, ethyl 2 methoxy-α methyl—*trans* cinnamate and ethyl 2:4-dimethoxy—*trans*-cinnamate do not give the expected coumarin derivatives on heating with hydriodic acid.

The synthetical method developed by the authors has, however, been employed for the synthesis of 3:4-dialkylated coumarin derivatives, which cannot be synthesized by the methods known at present. The results will be published in the *Journal of the Indian Chemical Society*.

Department of Chemistry, University College of Science, Calcutta.

D. Chakravarti.
B. Majumdar.

[1] Chakravarti and Majumdar, *J. Indian Chem. Soc.*, *15*, 136, 1938.

[2] Perkin, *J. Chem. Soc.*, *31*, 415.

[3] Perkin and Schiess, *J. Chem. Soc.*, 85, 162.

SCIENCE AND CULTURE

AUGUST 1938

VOL. IV NO. 2.

A Monthly Journal of Natural and Cultural Sciences

The Social Implications of Science

THINGS that happen before our eyes from day to day tend to be accepted by the common mind as a matter of course—as things for granted—although they, in fact, may result in revolutionary changes in our modes of life. The truly phenomenal advances in science and technology during the last two hundred years have affected almost every aspect of our individual and social life. None of us to day can have his food or take a step or write a line without using the inventions of science in one form or other. Nevertheless, even otherwise cultured men are not few who are ignorant of the elements of science and are not sufficiently conscious of the role that science is playing almost literally every minute in their life. This, by itself, would be a misfortune. But it is rendered all the more regrettable when it is considered that science, apart from working far-reaching changes in our social life, has now placed in the hands of man powerful engines of destruction which, if used by unscrupulous men or for unscrupulous purposes, can produce untold harm, and even wipe out whole communities.

The reality of the danger has never been so great to Western people generally as now. The rise of totalitarian States and the ruthless way in which the latest scientific discoveries are being used for aggressive purposes openly and unabashedly have struck terror in the minds of the people in the Western democracies,, who were relatively calm up till now. Mass dismissals of eminent scientific men in Central Europe for reasons of political conviction or religious faith have unnerved the Western democrats and scientists who were hitherto unmoved by the suppression of scientific and scholastic careers in colonial countries on political grounds by the governments of these democrats themselves. They were still unaware that suppression of freedom in any part of the globe is potentially dangerous to freedom even in their own countries, even as slums in a city are dangerous to the richer people themselves, who are directly or indirectly responsible for the slums. To-day the Western intelligentsia have become alive to the problem. It is now generally admitted that scientists themselves are to a certain extent to blame for this state of affairs, not because, as is sometimes erroneously argued, scientists are responsible for the discoveries and inventions, but because scientists, being naturally absorbed in their own work, have not paid due regard to the social implications of their work. They, as a class, have not tried to inform and train the public mind with regard both to the good and bad potentialities of scientific kiowledge and to instruct people to adjust social and international relations to the progress of science and technology. Efforts are now being made in America and in England and also internationally to make scientists conscious of the duty they owe to society in this regard.

The International Council of Scientific Unions set up last year a Committee on Science and its Social Relations, which was instructed to prepare a report on the effects of science on human life and social relationships and present its report in 1940. For this work the Committee is expected to receive collabo-

ration from national correspondents and scientific societies in various countries. The Council of the American Association for the Advancement of Science has also formally pointed out in a resolution the changes in the physical and mental environment of man and the complexities of social, economic and political relations that are being brought about by science and technology. Both the British Association for the Advancement of Science and the American Association are seriously considering these social problems created by science. Views of representative scientific men in Great Britain on this question were sought recently by *Nature* and there seems to be a general concensus of opinion that a society for the study of the social relations of science is needed. A concrete scheme for the organization of such a society and for its lines of work is naturally more difficult of formulation, but it constitutes at least a re-assuring symptom of the growing awareness of scientific minds to the urgency of the question. We consider it desirable that the Indian Science Congress Association should discuss this question in a plenary session in the forthcoming Lahore Congress, and, if necessary, organize a Committee for the study of this question. The social implications of science are even more ignored in this country than elsewhere, as the mass of the people is ignorant and illiterate. But India is as much within the orbit of the action of deadly scientific weapons as any other country. India, as a nation, is really at the threshold of her scientific career, and if her scientific men organize their thoughts betimes with regard to social, economic and political questions, it may be possible to arrest drift and guide her destinies in the direction of social progress and peace. India, like many other countries, abounds in quacks—medical, political and spiritual and the help of sincere scientists trained to study problem with objectivity and without prejudice may help to steer her course evenly in a sea of passion and unscientific thought.

It is, however, clear from the above that those scientists who are willing to study social problems must bring a scientific mind to bear upon this study. It is not infrequent that scientists, who pursue a scientific way of thought in the laboratory, fail to retain the same attitude in other affairs, and in the study of social questions considerations inspired by prejudice and selfishness have a knack of coming in unobtrusively unless kept at bay by a vigilant mind. It must be borne in mind that the present dislocation in the entire world is the result of maladjustment between scientific development on the one hand and social and international relationships on the other. Scientific methods of communication have largely wiped off the significance of geographical and even of linguistic boundaries. Mankind inevitably, by the impact of science, is moulding itself into one community economically, but the mental separateness persists, racial and national rivalries exist and have even aggravated, religious intolerance has in some countries increased. The light of science must dispel this darkness and show the way for mankind. If Indian scientists can form themselves into such a body with such a task, they will deserve well not only of India but of the entire world.

Electrical Charge Distribution in Thunderclouds

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THE phenomenon of lightning has been, for a long time, known to be a case of discharge of electricity through the atmospheric medium. The nature of the distribution of electric charge in the clouds and its surroundings, the cause of such an accumulation of charge to produce the lightning discharge and the nature of the lightning process itself are even now under various experimental investigations. Although success in some of the items may now be rightly claimed, it cannot be said that the whole phenomenon has been thoroughly explained and properly visualized as yet.

Normal Electrical Condition of the Earth and the Atmosphere

Before proceeding to study the problem of thunderclouds and lightning, one must be fairly acquainted with the electrical condition of the earth and the surrounding atmosphere in fair weather. It has been observed that a level field, freely exposed to the sky, is negatively charged. This means that the potential V in the lowest layers of the atmosphere increases with the height, the rate of increase dV/dH being given by $F = 4\pi\sigma$, where σ is the amount of charge per sq. cm. of the ground. The average magnitude of the positive potential gradient in fine weather is of the order of 100 volts per meter, corresponding to a negative charge on the ground of 3 e.s.u.= 10^{-9} coulomb per sq. meter.

The potential gradient soon begins to diminish, and before a height of 10 km. is reached the potential becomes almost independent of the height. Thus the potential, relative to the earth, of the whole upper atmosphere above regions of fine weather is less than one million volts. The normal vertical field of the atmosphere tends to drive positively-charged bodies downwards and thus gives rise to an air-earth current. The average air-earth current in normal conditions is about 2×10^{-16} ampere per sq. cm., that is, about 1,000 amperes for an area equal to the whole surface of the earth. The positive charge thus carried from the atmosphere to the ground in one minute is of the order of 1/10th the surface charge on the ground. It has, therefore, to be borne in mind that unless some other process has been working in a reverse sense, the earth would lose its whole negative charge in about ten minutes. The nature of this compensating process has long exercised the minds of physicists. One theory is that the lightning discharge brings a surplus of negative charge to the earth. In view of the fact that we have about 1,000 active thunderclouds over the earth at any instant, the continuance of the negative charge on the earth would be easily explained, if it could be shown that the discharge between the cloud and the ground gave negative charge to the ground and the thunderclouds induced an earth-air current of considerable amount.

Polarity of Thunderclouds

Whatever may be the process (the exact process has not yet been well established) which renders the thunderclouds electrically charged, it must be based on the fundamental idea that both positive and negative charges are created in the active sphere of a thundercloud and the two types of charges separate in different directions as in the charging of a condenser by the familiar *Wimshurst machine.* A thundercloud must, therefore, be electrically bipolar. If the charge in the lower portion of the thundercloud is *negative* the thundercloud is said to be of *positive polarity* and *vice versa.*

The general method of finding out the polarity of a thundercloud is to find out the electrical field on the surface of the earth in the presence of a thundercloud, whether near or distant, or the change in the

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field during a flash. The general method of finding out the field or the change of field on earth was devised by C. T. R. Wilson. In principle the method consists in determining the charge induced on an earth-connected conductor by means of a capillary electrometer. The earth-connected conductor could be of the form of a test plate lying on the ground and properly shielded or a copper sphere placed at a few meters above the ground and connected through the electrometer to the ground. If the capacity of the whole conducting system is known, the potential or the field is easily determined, from the reading of the electrometer.

Appleton and his co-workers, while studying the nature of the atmospherics, have used the cathode-ray oscillograph for the determination of the sign and magnitude of net changes of the earth's electric field due to a lightning. This, however, does not enable one to measure the steady field on the surface of the earth. The oscillograph yields, moreover, certain complex details, all of which have not yet been explained. Simpson tried to decide the question of polarity of thunderclouds on general grounds. He attempted to form a complete picture of the origin of charge distribution in a thundercloud, which automatically links up the question of polarity.

The origin of electricity in a thunderstorm was considered by Simpson to be due to the breaking up of water drops by an upward current of air. It was considered by him that, when a water drop is so broken up, the water particles acquire a positive charge and the air gets a negative charge. In the case of thunderclouds, generally, the air enters the cloud at its lower base and proceeds upwards in a slanting direction. The vertical component of the upward current of air increases as the air passes into the storm area and reaches a maximum at the lower half of the cloud. Outside the region again, the vertical velocity is less. Water drops cannot enter this region of maximum air current and are, therefore, checked, broken up and thrown upwards only to accumulate again and repeat the same process.

Some of these water drops, however, will slip downwards by the side of the region of maximum velocity. Regarding the electrical nature of the region it was considered that the process of breaking water-drops above the region of maximum velocity, *P*, gives a positive charge to the water drops in the area. The negative charge is carried away by the air and is distributed in the remaining cloud. The distribution of charges will, therefore, be as shown in the adjoined figure 1. We see from this figure that the heavy rain drops near the centre of the storm are positively charged and the rain

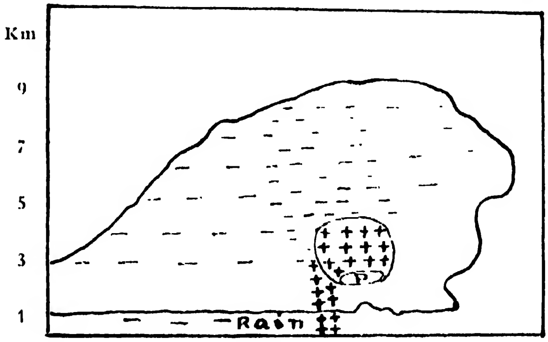

FIG. I.

drops in the region away from the centre are negatively charged. The separation of the charges convert the thundercloud into something like a huge condenser. Simpson says that the charge of the rain drops has sometimes been found to be positive and sometimes negative. Sometimes the rain drops have a mixture of positive and negative charges. This is, evidently, in accordance with his theory.

On the assumption that the air is unable to withstand more than a certain definite electrical intensity and that the mobility of the negative electrons is much larger than that of the positive ions, Simpson argued that a positive discharge is expected to create an intense field at the end of a *progressing* channel of positive charge, with a tendency to produce branches. A negative discharge, on the other hand, cannot produce a channel but forms a diffuse ionized region. Experimenting in the laboratory, he found a characteristic branched discharge from the positive terminal and a diffuse glow from the negative terminal. Further experiments with a positively charged plate to represent the earth and a negatively charged sphere to represent the cloud gave, at comparatively shorter distance, a thick discharge from the plate to the sphere. The general nature of lightning

photographs show many branched discharges and many unbranched thick ones, the majority being branched discharges downwards. Thus he came to the conclusion that the lower end of the active thundercloud is positively charged and the thunderclouds are, therefore, of *negative polarity.* This is evidently what the picture depicted by Simpson leads us to believe.

However elegant and complete the theory propounded by Simpson may appear, it has not stood the test of subsequent and more elaborate experiments of Schonland and other workers, who have definitely established that the thunderclouds are generally of *positive polarity.*

Experimental Tests on the Polarity of the Thunderclouds

The question of polarity of thunderclouds was first attempted by Wilson by studying the change of electric field on the earth due to a lightning.

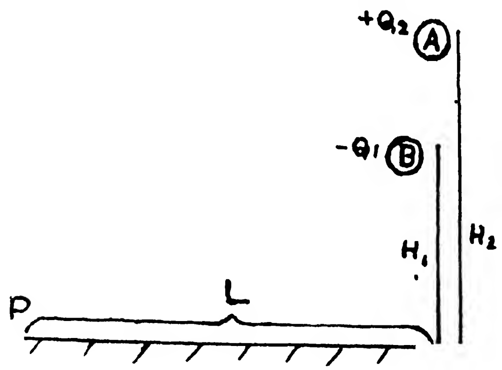

FIG. II.

From his observations he came to the conclusion that a great majority of the thunderclouds were of positive polarity, that is, the lower portion of the cloud was negatively charged. Experiments by Appleton, Watt and Herd with the oscillograph also supported the idea of positive polarity of the thunderclouds. Schonland and his co-workers are responsible for the elaborate and definite proof on the question of polarity of the thunderclouds. The recording apparatus used by Schonland was like that of Wilson,—a copper ball or a test plate worked along with a capillary electrometer. As a preliminary to the working theory, it is considered that thunderclouds are essentially bipolar. In a bipolar cloud of the ideal condition shown in the figure II, the field at the point of observation P is given by,

$$F = \frac{2\,Q_2\,H_2}{(H_2^2+L^2)^{3/2}} - \frac{2\,Q_1\,H_1}{(H_1^2+L^2)^{3/2}}$$

where Q_1 and Q_2 are the negative and positive charges and H_1, H_2 their heights from the ground, L is the distance from the base of the cloud to the point of observation. For distances L less than a certain critical value, the second term predominates and for large distances the effect of the first term predominates. *Thus with increasing distance L between the cloud and the station the field will change its sign.* In general, however, this may be difficult to observe due to the presence of several thunderclouds at varying distances.

Electrical nature of the cloud may also be determined by studying the change of field associated with a lightning discharge. We may consider three types of lightning discharges, that between the positive or the negative charge and the earth, or between the two poles of the cloud. Writing C for the earth and A and B for the positive and the negative poles of the cloud, the sudden change of field resulting from the various discharges may be given by the following expressions, —

Discharge AC [positively charged part of the cloud to the earth

$$\Delta F = -\frac{2\,Q_2\,H_2}{(H_2^2+L^2)^{3/2}}$$

" BC [negatively charged part of the cloud to the earth

$$\Delta F = \frac{2\,Q_1\,H_2}{(H_1^2+L^2)^{3/2}}$$

" AB [Lower Cloud negative], ΔF

$$-2\,Q_2\left[\frac{H_2}{(H_2^2+L^2)^{3/2}} - \frac{H_1}{(H_1^2+L^2)^{3/2}}\right],\ Q_1>Q_2$$

$$-2\,Q_1\left[\frac{H_2}{(H_1^2+L^2)^{3/2}} - \frac{H_1}{(H_2^2+L^2)^{3/2}}\right],\ Q_1<Q_2$$

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It is evident as in the case of the steady field, previously discussed that the pole to pole discharge gives a reversal in the change of field observed as the distance changes. This can be tabulated in the form :—

Discharge.	Sign of sudden field change. Distant cloud of positive polarity.	Near cloud of positive polarity.
AB	Negative	Positive
BC	Positive	Positive
AC	Negative	Negative

It has been observed that the great majority of lightning discharges pass between the upper and the lower parts of the cloud. Discharges from the lower pole to the earth are less frequent, while the discharges from the top pole to the earth are rare. With a cloud of positive polarity, generally, all *distant* discharges within the cloud (*AB*) should produce negative change of field, while lightning discharge in a near cloud of positive polarity (*AB*) should produce positive change of field.

If the observed positive field changes due to distant discharges are all associated with discharges to the ground, *C*, then, it may be said that no positive field changes are associated with discharges between the clouds and the cloud is of positive polarity.

The steady fields due to near and distant storms are respectively positive and negative for negative polarity and negative and positive for positive polarity. In view of the superimposing fields this is, however, not an absolute criterion.

The records of observation definitely favour a positive polarity of the cloud.

(1) Out of 523 *distant* discharges *within* the cloud 517 were associated with negative field changes and 6 with positive. (Type *AB*).

(2) Out of 54 positive field changes of distant clouds 48 were associated with discharges to the ground. (Type *BC*).

(3) Positive steady fields were associated with distant storms and negative steady fields with near storms.

These observations of Schonland have been later verified by Halliday and others. Having thus established that the thunderclouds are of positive polarity, that is, the base of the cloud is negatively charged, it can now be explained why in spite of the steady air-earth current of normal conditions (positive charge moving to the ground) the earth maintains the constant negative charge on its surface.

Explanation of the Negative Charge on the Surface of the Earth

Wilson was the first to suggest that the exchange of electricity between the thunderclouds and the ground may be an important factor in the maintenance of the earth's negative charge, the replenishment of which, in view of the fine weather air-earth current, is an outstanding problem of atmospheric electricity. This exchange can take place in three ways, *viz.*, by the momentary currents due to lightning discharges between the cloud and the ground, by the total charge carried by the downpouring rain, and by the continuous current carried by the ions in the powerful electric field between the cloud and the ground. The last effect is expected as a result of point-discharges from trees and bushes below the cloud.

Occasions of strong positive fields below active thunderclouds are negligible. There is a preponderance of strong negative fields, which causes the point discharge current to be mainly upwardly directed. The earth must, therefore, gain a negative charge from this effect. It has been shown that the lightning discharge takes place between the negative cloud and the earth. The earth, thus, gets a negative charge from this effect also. The rain, on the other hand, may be expected to convey a positive charge to the earth, as the falling drops, whatever their initial condition, will intercept enough of the positive ions before reaching the ground.

In order to estimate the point discharge currents from trees and bushes below the cloud, Schonland selected some natural source of point discharge, which is a typical tree in the region in which the experiment was carried out. This was cut down at the base and mounted upon sulphur-ebonite insulators. The tree was joined to a current-measuring instrument, the connecting wires being properly shielded. A unipivot galvanometer was used as the current measuring instrument, which was earthed properly.

It could read to tenths of a microampere. The current observed rapidly increased with the increase of field, as will be seen from the following table:

Steady field on the surface of the earth Volts/meter.	Current in microamperes.
—3,500	·07
—5,500	·20
- 11,000	1·00
- 16,000	4·00

Positive fields being due to distant storms are never very powerful and, therefore, the current is always negligible. Measuring the average current due to the various storms at different distances and finding out of the chief sources of point discharges and their relative abundance, Schonland made a rough estimate of the total point discharge current between an active thundercloud and the ground. He found this current to be 2·1 amperes. The effect of momentary currents carried by lightning discharges is ·1 ampere in an upward direction, charged rain carries 0·02 ampere downwards.* In view of the abundance of active thunderstorms at any time, it is probable that the air-earth current is well balanced by the gain of negative charge by the earth due to thunderstorms.

Determination of the Electric Charge Distribution in the Thundercloud

In a very recent experiment, Simpson has measured the potential fields in the thundercloud itself, by means of sounding balloons and has found out the general nature of the charge distribution in the clouds. These results are in general agreement with the idea of the positive polarity of the majority of the clouds, thus tallying with Schonland's results and with those of others. Simpson has also modified his theory to suit the general nature of the charge distribution in the clouds as found new, and has carried out further laboratory experiments to justify his theory.

* Recently Dr S. K. Banerjee has reported that he has found the total charge carried by raindrops to be negative and of sufficient amount.

The main principle of his work was to attach a point-discharge system with a sounding balloon. The record of the discharge was imprinted on a chemical paper which was made to rotate by means of a clockwork. Arrangements for recording the humidity and the pressure were also sent along with the balloon. All the scientific instruments were released by means of a fuse at any desired height and these came down by means of a parachute. The soundings were generally made in thunderstorms or in showers.

The records show that at least two-thirds of the soundings give a negative potential in the lower regions up to 3 km., which is usually above the base of the thunderclouds. From the top of the negative gradient up to eight or nine kilometers positive gradients predominate. The evidences at greater heights point to negative potential again. There are, however, also cases on record, which start with a positive potential, change to a negative potential and again pass over to a positive potential. These records indicate that although generally the charge in the lower part of the cloud is negative and the upper part positive, there are some cases where the balloon meets a positive charge to start with and then comes to a negatively charged region followed again by positive charge. It has been further calculated that the centre of gravity of the main negative charge lies in the region of temperature above 0°C, while the centre of gravity of the positive charge lies in the freezing temperature region of -10°C. The specimen records are well illustrated by Z_1 and Z_2 in the following figure III,

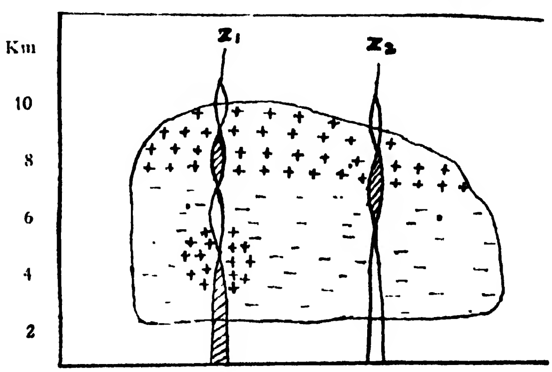

FIG. III.

where the shaded portion denotes the positive gradient and the unshaded ones the negative

gradient. The majority of the records are of the type Z_2. These records are explainable on the basis of the cloud charge distribution shown in the figure. The modifications necessary from the earlier theory of Simpson arise from the fact that there is a large positive charge at the top of the cloud and the negative charge in the general cloud is much denser. This means that the general nature of a thundercloud charge is positive above and negative below, while only under specially selected regions a concentration of positive charge is found embedded in the lower region. The previous breaking drop theory of Simpson had accounted for the concentration of positive charge in a limited lower region. As regards the upper positive charge, it is now suggested that the mutual impact of ice crystals results in the ice becoming negatively charged and the air positively charged. This is based on observations made in the Antartic by Simpson. In view of the fact that the upper region of positive charge is below the freezing point temperature, occurrence of ice crystals in the region is according to expectation. The general settling of negatively charged ice would then result in a separation of electricity with the positive charge above the negative. Simpson, however, points out that this explanation has not yet been confirmed by satisfactory laboratory experiments.

Conclusion

In conclusion, it may be suggested that there are two types of thunderclouds generally. One, that is associated with considerable amount of rain and the other, which is not associated with much of rain. In the whole series of experiments by Schonland in South Africa, during the three months in which a considerable number of thunderstorms were studied, only 2·02 inches of rain fell. Scarcity of rain suggests smaller water drops and, therefore, one should not expect the breaking of drops to occur in such cases. The absence of this mechanism would indicate that there is no accumulated positive charge in the lower region of the thunderclouds. In the case of thunderclouds associated with much rain one expects the breaking of water drops process to be in force and hence an accumulation of positive charge somewhere in the lower strata. By studying the potential gradient in these two different types of clouds, one could try to verify the theory of breaking-drops given by Simpson. As regards the suggestion that the ice crystals settle down gradually with negative charge, giving the positive charge to the air above, it is possible to try various laboratory experiments to test it and before the theory can be definitely accepted one must find out the verification. In view of the large number of thunderstorms occurring in India, we are in an advantageous position to make some contribution to this interesting problem before it is finally settled.

Pluto May Be Larger Than Supposed

Pluto, the ninth planet of the sun's family, may be larger in size than now estimated. Sir James Jeans has suggested that this distant planet is so remote and cold that it is covered with a layer of liquid air.

Acting like a mirror, this supercold liquid air would give a minute image of the sun. This is what astronomers would see when they observe the planet. The sunlight from the outer portions of the disk would not reach the earth. The apparent brightness of Pluto would give a too conservative idea of its size. A size for Pluto larger than that of the earth, which might be possible according to this theory, would support the idea that Pluto exercises a noticeable effect on both Neptune and Uranus. This was the basis of the late Prof. W. H. Pickering's prediction of a ninth planet made before Pluto was discovered.

—*Science Digest.*

The Origin of the Planets

James H. Jeans

As soon as the reasoning of Copernicus and the observations of Galileo had elucidated the nature and motions of the planets, hypotheses and speculations as to their origin were put forward in profusion. Theories were propounded by Descartes in 1644, by Swedenborg in 1734, by Thomas Wright in 1750 and by Kant, the philosopher, in 1755. Finally Laplace in 1796 put forward his famous "nebular hypothesis," which was destined to hold the field almost unchallenged for nearly a century.

Laplace's Theory of Nebular Origin

Laplace first noted that all the planets revolve around the sun's equator in the same direction, namely that in which the sun is itself rotating. This led him to conjecture that the matter of the planets had originally constituted, or formed part of, a vast atmosphere which enveloped the rotating sun and rotated with it, so that the sun at this stage had formed a vast gaseous nebula with the present sun forming a stellar centre. Gradually this nebula cooled. As it cooled it shrank, and continually spun faster and faster in accordance with the well-known principle of the conservation of angular momentum. Finally a speed was reached at which the nebula could no longer hold together as a single body; just as a fly-wheel breaks up if it is spun too fast, so the great nebula broke up, and out of the debris the planets were formed.

Laplace studied the method of break-up in some detail. The shrinking sun, he found, would continually leave matter behind in its equatorial plane. This would continue revolving round the sun at the speed at which it had rotated while it still formed part of the sun's equator, and so at a slower rate than that at which the sun was then rotating. He imagined that this slowly-rotating matter would condense in due course into a planet, after which the process would begin again, until a second planet was born, and so on.

Laplace was too good a mathematician to go wrong in his mathematical theory, but the Kinetic theory of gases was still unknown, and he went wrong in his physics. We know now that a stream of gas slowly liberated from the equator of a rotating sun would not condense into planets; instead, its atoms or molecules would scatter into space, precisely as the molecules do when we turn the gas-tap on in the laboratory, and for the same reason. It is true that structures are known in the heavens—the great spiral nebulae—in which the process imagined by Laplace is very probably in progress, but these are on an entirely different scale. Each of these nebulae contains about 100,000,000,000 times as much matter as the sun, and the difference of scale introduces essentially new factors into the problem. Condensation can, and must, occur when the matter is so abundant that its gravitational attraction outweighs the tendency to molecular scattering; it cannot occur on the relatively puny scale contemplated by Laplace.

Laplace pointed to the rings of Saturn as evidence that the process he had in mind could really occur, and a study of these rings takes us into the heart of the problem. Laplace thought that these rings were a satellite in its pre natal stage; we now think, with reasonable certainty, that they are a satellite after its death. 1852 the French mathematician Roche made a study of the question which most astronomers of to-day find conclusive.

Roche's Theory of Tidal Origin

Let us begin by considering the ordinary everyday tides which the moon raises on our earth. These consist of tides in the ocean which are of moderate height, because water is easily pulled about, and of smaller "earth-tides" in the solid body of the earth-smaller because the earth is denser and more rigid than water. The earth must, of course, produce similar tides in the solid body of the moon;

these are larger than the foregoing, because the earth, owing to its greater mass, exerts a greater gravitational pull than the moon. If the moon were to come closer in to the earth, the earth's gravitational pull on the moon would increase, and these tides would become still greater. Yet Roche found that, in every such case, there is a limit to the height of the tides which will be raised on the smaller body; if this comes too near to the larger body it does not have mere tides raised on its surface, but is pulled in pieces. So far as we can foresee, the moon is destined in remote future ages to come closer and ever closer in to the earth. As it does so, the earth's tide-raising pull on the moon will for ever increase, until finally the moon will no longer be able to resist the strain; it will no longer hold together as a single body, but will break into fragments. We shall no longer have a single moon, but a swarm of minute satellites, like the rings of Saturn, revolving round the earth.

What our satellite will do in the future, we believe that a satellite of Saturn has done in the past. The orbit of this satellite must, we think, have continually contracted until the strain of Saturn's tide raising gravitational field became too great for it, and it broke into the fragments we now see.

The sky exhibits what appear to be other instances of the same phenomenon. There are comets which have broken into several pieces between successive appearances; some have actually been observed in the act of breaking. Again, according to Bode's law, we ought to find a planet between the orbits of Mars and Jupiter; instead of this we find a whole swarm of minute planets--the asteroids —which most astronomers think were probably formed by the break up of a single planet in the way just described.

According to the tidal theory of the origin of the solar system— at any rate in the form in which I propounded it in 1916--the planets were formed by a somewhat similar break-up, although with one essential and important difference in the conditions. The imagined satellite of Saturn was, we think, broken up by the gravitational attraction of a larger mass round which it described a circular or elliptica orbit. The tidal theory supposes that the sun was broken up by the gravitational attraction of a second star, but round this it would of course describe a hyperbolic orbit. Now a hyperbolic orbit involves only a transitory visit to the region of danger in which break-up occurs, whereas an elliptic or circular orbit involves repeated visits to this region, or even a permanent stay inside it. Mathematical analysis shews that if the sun made a transitory visit into the region of danger of another star, the gaseous tides on its surface would rise continually higher, until finally a long filament of gas would shoot out towards the second star. When the two bodies receded from one another, this filament would be left suspended in space, with a motion of revolution round the sun which would prevent its falling back into the sun. It can be shewn that the filament of gas would condense into globules of gas which would be of the general order of size of planets. The theory suggests that these are in fact the actual planets. They would begin by describing orbits about the sun and if these orbits brought them near enough to the sun, they might themselves be broken up and give birth to systems of satellites.

Such, in its simplest form, is the tidal theory and it obviously explains many of the observed features of the solar system. We see at once why the planetary motions have reference to two planes - the plane of the sun's rotation, and the plane in which the outer planets revolve. Clearly the former must have been the plane of rotation of the original sun, while the latter would be the plane in which the second star passed by the sun. We see too why the largest planets, Jupiter and Saturn, are found in the middle of the sequence of planets, while the size tails off at either end of the sequence. For the matter out of which these central planets were formed would have been emitted when the two stars were at their closest approach, the stage in which matter would be emitted most profusely, and so might, we may conjecture, form the largest planets. Further, these central planets, being the largest, would cool most slowly, from which it can be deduced that they ought to be surrounded by numbers of small satellites, while the smaller planets should be surrounded by a few relatively large satellites. Actually we find a regular sequence in the numbers of planetary satellites—0,0,1,2?,9,9,4,1,?. The tidal theory at least makes this regularity intelligible, while no other theory with which I am acquainted attempts to explain it.

THE ORIGIN OF THE PLANETS

Difficulties of the Tidal Theory

Dr Jeffreys and others have recently drawn attention to a difficulty which affects this theory in common with all other that suppose that the planets originally formed part of the sun. The sun rotates once in about twenty-six days, Jupiter once in ten hours. The matter which now forms Jupiter, and rotates once every ten hours must at some past time, so these theories suppose, have rotated once only in twenty-six days. What has produced the increased rate of rotation? It cannot have been mere shrinkage, since calculation shews that if this were the only cause in operation, the original Jupiter must have been larger than the sun. Clearly then some external force must have got a rotational grip on the matter and set it spinning faster. The difficulty is to find any external force of sufficient potency.

As the tidal forces from the passing star could at best set up only a very slight amount of rotation, it is usual to attribute the main part of this rotation to the falling-back into the planet of matter which had been drawn out of it tidally, but had not sufficient angular momentum to form satellites. Jeffreys has calculated that Jupiter's present rotation could be produced by the falling-back of matter totalling one-fift of whole mass of the planet.

This certainly seems a large mass. Jeffreys, nsidering it to be inadmissibly large, has proposed replacing the tidal action of a second star by a grazing collision with a second star. The matter near the point of collision would then be caught between the upper and nether millstones formed by the two stars, and set into rapid rotation. This brings us very near to the collision " hypothesis which was propounded by Bickerton of New Zealand in 1880; either hypothesis gives adequate rotation to the planets.

Professor H. N. Russel has drawn attention to a second, and perhaps more serious difficulty, which emerges from a study of the angular momentum of the planets round the sun.

Calculation shews that, if planets were to be formed at all, the second star must have passed fairly close to the sun's surface probably within two or three radii of it. A less close approach would have resulted merely in a rise and subsequent fall of tides on the sun's surface. Knowing the distance within which the second star must have passed for planets to be formed, we can calculate an upper limit to the angular momentum per ton which this star could have had around the sun. It is hard to see how the encounter can generate more angular momentum per ton than this in the ejected matter, so that we should expect that this same figure would set an upper limit to the angular momentum per ton of the planets. But in actual fact the planets all have substantially more angular momentum per ton than this expected upper limit -Neptune twenty-two times as much, Saturn twelve much, Jupiter nine times as much, and so on. To state the difficulty in more physical language, the whole encounter on which the tidal theory relies must have taken place well inside the orbit of Mercury: what force, then, can have projected Jupiter, Pluto, etc., out to where they now are?

Lyttleton following a suggestion of Professor . N. Russel, has tried to find an escape by supposing that the sun was originally half of a binary system, the other constituent of which has been captured by the second star of the tidal theory. He believes that this gives an adequate account of the angular momentum of the planets, but Luytons and Hill have challenged his analysis, and issue is still in doubt.

Milne has recently developed a new and very revolutionary system of dynamics in which angı momentum does not stay constant in the absence of external forces, but increases steadily with the time. This of course removes all the difficulties which arise from excess of rotation and angular momentum, not only from this problem, but from many other problems of cosmogony. But it has not so far gained many adherents.

While it has to be admitted that these questions of rotation introduce certain difficulties into the tidal theory, the many successes of the theory seem to me to suggest that it is nevertheless fundamentally on sound lines.*

*Lecture delivered by the author at the Indian Association for the Cultivation of Science.

Chemical Composition and Nutritive Value of Bananas

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BANANA is an important crop most successfully cultivated in hot and damp climate of all tropical and subtropical regions.

The northern limit of its cultivation is reached in Florida, Canary Island, Egypt and South Japan, and the southern limit in Natal and south Brazil.

Description of the Plant

The plants are gigantic herbs with what at first appears like a tall stem but which in realty is the base of the leaves one closely enveloped into another. A true stem develops at the flowering period which grows up through the hollow tube formed by leaf sheaths. The emergent end bears a tuft of a large number of tubular flowers encircling the stem top in bunches with a patch of protecting bract over each layer of floral row. The flowers in due course take the shape of banana fruits which form dense clusters.

The cultivated form of the plant is propagated entirely vegetatively, since the fruit usually contains no seeds. In one variety seeds are often to be found as hard round bodies in the flesh of the fruit, but in the rest of the order they occur with merely perisperm or growth of the nucellar-tissue of the ovule.

The plants belong to the genus *Musa*, (natural order *Musacae*) derived indirectly from the word "Mocha".

Early mediaeval travellers generally used to call the fruit either "fig of paradise" or "fig of India."

The most generally used fruits are obtained from *Musa paradisica*, of which an enormous number of varieties and forms exists in cultivation. The subspecies *Sapientum* is the source of the fruit generally known as banana and eaten raw, while the name plantain is given to forms of the species itself (*M. paradisica*). The species is probably a native of India and southern Asia.

From the Indian standpoint some of the most important forms are:—Dâccâi, Martamân, Châmpâ, Kântâli, Râmkalâ, etc. The peel of the fruit while ripe generally exhibits brownish yellow colour, but there is a particular variety grown in India which retains its green skin when ripe. Râmkalâ, the characteristic high-class banana of Bombay, is of a very dark red colour while immature but it finally ripens into a yellowish red.

Bananas after mangoes are the commonest of all Indian fruits, while the coarser kind constitutes one of the staple articles of diet in many parts of India and Malay Peninsula. Just as wheat and barley have played their part in more temperate regions, so the banana has played its part in the tropics. It is said by some authors that the produce from one acre will support a much greater number of people than a similar area under any other crop. The fruit is obtainable in abundance at all seasons. In the winter months especially it provides an inexpensive food particularly needed in the diet often too low in fresh fruits.

In temperate lands a supply of fresh fruits is a luxury as a rule. The London poor have, however acquired the habit of giving their children bananas, because such fruit is cheap in London, which is the centre of distribution for the English fruit trade. Probably the first importation of bananas into the United States of America was made somewhat more than one and a quarter century ago. At that time thirty bunches were brought from Cuba to New York. In 1929 the

CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF BANANAS

total importations were sixty-five million bunches. Similar figures may be cited for countries of Europe. These facts indicate that banana though a native of the tropics is getting to be more and more a popular food in America as well as in Europe. American and English market demands have greatly accelerated the cultivation of bananas in Jamaica.

Nutritive Constituents and Caloric Value

From the standpoint of nutrition the banana is essentially a highly edible source of carbohydrate, comparable in its richness of foodstuffs with the most popular of fruits. The fat and fiber are negligible. The ash is important both in amount and constituent.

The banana has a high fuel value, yielding over four hundred calories per pound. A single fruit weighs on an average 101 grams and contains 100 calories.

An interesting comparison of the edible portion (average) of the banana with that of other fruits is given at the next column from the Bulletin, U. S. Department of Agriculture, Washington.

	Water.	Protein.	Fat. %	Carbo-hydrate %	Ash. %	Fuel value per lb. calories.
Bananas ..	75.3	1.3	0.6	22.0	0.8	460
Grapes ..	77.4	1.3	1.6	19.2	0.5	450
Cherries ..	80.9	1.0	0.8	16.7	0.6	365
Apples ..	84.6	0.4	0.5	14.2	0.3	290
Oranges ..	86.9	0.8	0.2	11.6	0.5	240
Peaches ..	89.4	0.7	0.1	9.4	0.4	190
Muskmelons	89.5	0.6	..	9.3	0.6	185
Strawberries	90.4	1.0	0.6	7.4	0.6	180

Protective Coating

Extensive bacteriological examination of bananas has been made in different stages of their maturation, all of which justify the conclusion that the inner portion of the pulp of sound bananas is practically sterile. A banana properly handled is uncontaminated by dirt and pathogenic germs. Even when bananas were subject to the exceptionally severe test of being immersed in fluids containing cultures of known organisms there was no evidence of a penetration into the interior. The probability of infection through the peel is, therefore, very slight.

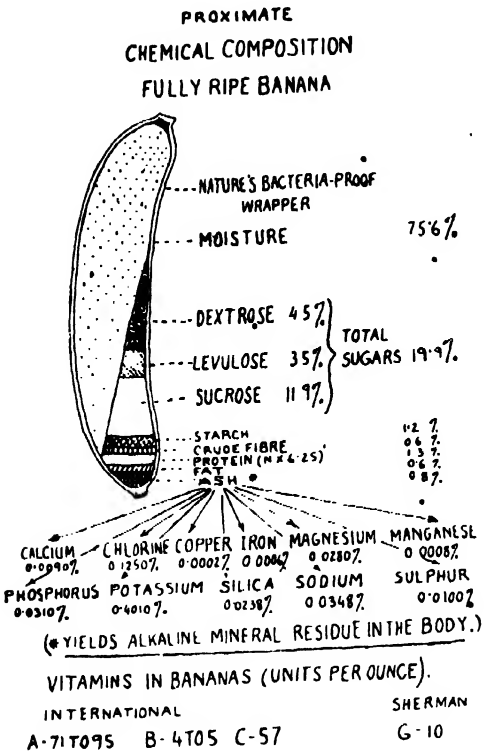
Proximate Composition

The following figures indicate proximate chemical composition of fully ripe bananas:—

	Refuse. %	Water. %	Protein (N.X. 6.25). %	Fat. %	Ash. %	Carbohydrates. Total by differences incl. fibre. %	Carbohydrates. Fibre. %	Carbohydrates. Sugars as Invert. %	Carbohydrates. Acids as Malic. %	Fuel Value. Per 100 gram. Cal.	Fuel Value. Per 100 pound. Cal.
Average ..	.. 33	74.8	1.2	0.2	0.84	23.0	0.6	19.2	0.39	98.6	445
Probable error	.. 2.6	2.4	0.2	0.2	0.11	..	0.3	1.7	0.08	..	..
Maximum ..	.. 40	83.4	2.0	1.4	1.4	..	1.8	25.7	0.55	..	..
Minimum	.. 23	65.4	0.8	.0	0.5	..	0.2	14.5	0.26	..	..
As purchased	.. ..	50.1	0.8	0.1	0.6	15.4	0.4	12.9	0.3	66	300
No. of Samples	.. 34	69	59	39	62	..	18	36	21	..	..

CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF BANANAS

Bananas are richer in solids and lower in water content than other fresh fruits. But they have very little protein and fat. The green banana contains, in the part exclusive of the skin, about 1.5 per cent of protein, 20 to 25 per cent carbohydrate and almost all the rest starch. In the ripe bananas with the yellow-brown peel, the edible part contains somewhat less (16 to 19 per cent) of carbohydrate; but that which remains is now almost in the form



of soluble sugars. Broadly speaking, the ripe banana is about one-fifth sugar, the green one-fifth starch. Most of the remainder of the edible pulp is water. Its small quantity of protein and fat enables the dietarian, as is often necessary, to increase caloric values, without appreciably adding the protein content. This is of great value in diseases of the kidneys.

Whereas five parts of potato protein may replace four of body protein in establishing body equilibrium, the protein of bananas is not so efficient. Yet in the tropical countries, such as the seacoast of East Africa, the Congo and Pacific Islands, during the six months of the rainy season (in which the banana is ripe), it furnishes almost the exclusive diet of the natives. It is preferred to potatoes because it can be obtained almost without labour.

Mineral and Ash Content

Banana is rather similar to potato; the calorie contents are about equal; so are the nitrogen contents, the carbohydrate contents and the ashes.

The ash content of banana is higher than that of any other fruit. In the different varieties of banana mineral contents and acid remain nearly identical. Its mineral content is worthy of mention especially in view of the fact that iron, copper and manganese are present, iron being more readily assimilated in presence of the other two minerals. Chemical analysis shows that within 0.8% average ash-content of fully ripe bananas, mineral constituents are present in the following proportion as per cent of the banana:-

Calcium	0.0090
Chlorine	0.1250
Copper	0.0002
Iron	0.0006
Magnesium	0.0280
Manganese	0.0008
Phosphorus	0.0310
Potassium	0.4010
Silica	0.0238
Sodium	0.0348
Sulphur	0.0100

A Source for Haemoglobin Formation

There is a preponderance of calcium and magnesium over phosphorus which makes the ash alkaline and so bananas help to combat a tendency towards acidosis. The minerals of banana have blood-building properties.

Periodic haemoglobin determinations made on many babies indicated that they maintained a comparatively high haemoglobin percentage while on

banana-sugar feeding. This may be attributed to the iron, copper and manganese content of the banana sugar. Banana powder was examined for its available iron content both by a chemical method and by feeding experiments on nutritionally anaemic rats. The chemical dipyridyl method employed indicated a high degree of availability, 90 to 100 per cent of the total iron content (0.00245 per cent). The biological experiments showed that all of the iron in banana powder was available for the building of haemoglobin provided ample copper was supplied to permit complete utilization of the iron. The U. S. Department of Agriculture gives the following figures on the iron content of seven specimens of fully ripe, peeled bananas purchased in the months of February, April, and November;—

	Iron per cent.
	0.00031
	0.00048
	0.00026
	0.00037
	0.00173
	0.0008
	0.0005
average	0.00064

Alkalinity

A table of alkaline ash foods refers the degree of alkalinity of the banana as 5.56 c.c. N-NaOH per 100 gm. Bananas are included in a list of foods rich in sodium chloride.

The final products of metabolism of the banana in the body are alkaline. In diets in which banana forms a considerable part, the reaction of the urine is distinctly alkaline and for this reason it can be used to great advantage in cases of varying degrees of acidosis so commonly found among all classes of people.

Children from 5 to 13 years of age were studied in groups of four; two on mixed diet without bananas, and two on the same diet with 3 to 6 bananas substituted for a corresponding quantity of carbohydrate. After a suitable interval the diets of the pairs of a group were transposed. Representative samples of the food intake, the total urinary and faecal output of each child was collected for a four-day period. There was always a somewhat smaller daily volume of urine and a somewhat greater output of faeces in the banana-feeding than in the control periods, but never any diarrhoea on banana diet. The urine was always distinctly more alkaline with the banana food than with the control diets. as shown by pH values.

Meals with a high buffering-value help to hold, and liberate slowly acid which serves to kill bacteria ingested one or more hours after the taking of a meal. In order that the bacteria may be killed, it is important that the gastric contents develop an acidity as high as or greater than pH = 2.

Albumen

After drinking contaminated liquids, the taking within a short interval of time another meal, perhaps well buffered and somewhat alkaline will tend to wash living bacteria, left behind in the nasopharynx or oesophagus by the infected meal, directly into the bowel. It has been found that banana pulp serves as a well-buffered meal to hold HCl in the stomach. 100 gms. of banana dry contain 1.5 gm. of albumen. If it is desired to serve a diet very low in albumen, some physicians resort to a daily *menu* of 1,400 gms. of banana pulp which give 19 g. of albumen, 1.8 g. of salt, 1,225 calories. This is specially required for patients afflicted with diabetes.

Sugars

Carbohydrate of bananas comprises about 22 per cent of the total weight of ripe banana. This consists of a mixture of sugars chiefly sucrose, dextrose and levulose, which is very well digested and absorbed even by infants and young children with gastro-intestinal disturbances. A typical analysis of the carbohydrate in edible portion of banana is given below:

Glucose	5.82%
Fructose	3.78%
Sucrose	6.58%
Starch	3.02%
Total available carbohydrate ..	19.20%

CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF BANANAS

Transformation of Carbohydrate

The first product of photo-synthesis that can positively be identical in the veins of the leaves is saccharose. It then reaches the petiole concurrently with transformation into invert sugar. The inversion continues throughout the length of the petiole to such an extent that the saccharose, which predominates in the veins, forms but a small portion of the sugars present at the base of petiole.

From the base of petiole the mixture of soluble sugars is transported to the peduncle of the bunch, without undergoing any notable modification, and penetrates into the fruit.

The ripening process in banana is characterized by the starch which is present in the fruit pulp in large quantities, being gradually dissolved through enzymic influence and changed into sugar. In the ripe banana the originally harsh taste vanishes, and is replaced by the well-known and most agreeable banana aroma, due primarily to slight amounts of amyl acetate. Little acetaldehyde is present in frozen bananas, the ripening process of which has been interrupted; a much larger amount is noticeable in ripe bananas.

Studies on Ripening

Analysis has shown that during ripening the banana starch is transformed into cane sugar and the cane sugar into invert sugar, that there are important changes in the character of the tannin compounds, and that other changes occur, brought about by the production of aroma and flavour and in other ways. Studies made with banana-ripening by the help of respiration calorimeter show that the ripening changes progress regularly to a maximum and then decline, that at its greatest intensity heat produced is approximately one-half to one caloric per hour per kilogram of bananas. The heat liberated is a measure of the activity of one or more of the ripening processes.

Progressive maturity causes constant changes in the carbohydrate content from starch to sugar during the ripening process in a normal form even after the fruit has been detached from the stem. Inversion of saccharose, however, proceeds very slowly; it seems that the premature detachment of the fruit from the stem is responsible for this. Complete inversion will take place only under favourable temperature conditions.

Ripening experiments made on green bananas which were carried out in a large respiration calorimeter or in a specially designed ripening chamber indicate that the usual carbohydrate changes—saccharification of starch with formation of sucrose and invert sugar, and consumption of sugar in respiration—proceed with uniformity in bananas of different bunches. The period of most rapid respiration corresponded closely with that of most rapid starch hydrolysis. The quantities of ash, protein and ether extract undergo but slight changes during the ripening of the bananas. Pentosans decrease markedly in the pulp, but remain little changed in the peel.

Effect of Ethylene on Ripening

Bananas ripening in an atmosphere containing 1:1000 parts of ethylene turn yellow at a somewhat rapid rate than do the controls. Such bananas also show a slightly greater increase in sugars and decrease in starch from day to day than do the controls. Concentrations of ethylene ranging from 1:100 to 1:10,000 all seem equally effective in bringing about the small differences observed. Ripe bananas have 12-20 per cent of total sugars, 10-14 per cent of sucrose, and less than 1 per cent of starch. Respiratory activities of bananas treated with ethylene differ little or not at all from those of the untreated ones. Rarely is there found a bunch of bananas which is in a quasi-dormant condition and in this case ethylene stimulates an immediate commencement of ripening.

Enzymes

During ripening the starch in the banana is converted into sugars by means of enzymes. A ripe banana contains as high as 18 per cent of reducing sugars. The enzyme capable of hydrolysing the starch of banana and of converting cane sugar to invert sugar is destroyed by temperatures above 150°F. The properties of the gel obtained from banana extract by treatment with calcium-salts and alkali or with pancreatin and of banana sucrose were studied. It was shown that different substances

were involved in the gel formation and in the enzyme actions, although boiling the solution destroyed both properties.

The sucrose of unripe and ripe bananas was extensively studied. With ripe bananas both soluble and insoluble sucrose preparations were obtained. Conditions for converting the soluble into an insoluble form were found. The action of the sucrose preparations as far as the hydrogen ion concentration for maximum action relation is concerned is similar to the behaviour of the yeast and the potato sucrose. The optimum hydrogen ion concentration for the activity of sucrose from banana was found to be *p*H 4.0. The banana sucrose is definitely retarded by the presence of citrate, phosphate, phthalate and acetate buffers. This retarding effect increases with increase in buffer concentration. It was found that the sucrose activity of banana extracts increased as much as 40-160 per cent upon standing for a short time and then decreased again. The nature and amount of increase was found to be dependent upon the state of ripeness of the banana at the time the extract was made. Cause for this increase could not be determined. Extensive investigation has failed to show the presence of amylase in the banana, although the conversion of starch to sugar in this fruit is remarkably rapid.

Malic Acid

Malic acid which is easily and completely utilized was found to be the only non-volatile organic acid present in the ripe banana.

During ripening of the banana the malic acid content increases to a peak, then gradually decreases as the fruit matures. At the stage of ripeness at which bananas are usually eaten the malic acid content is approximately 0.3%.

Fatty Acid

The amount of fatty acids liberated by the hydrolysis of banana starch free from extraneous fatty material has been determined to be 0.2%. The fatty acids have been found to consist of a mixture of palmitic, oleic, linoleic (linolic) and linolenic acids together with a very small amount of phytosterol.

Tannin

The tannin content of bananas remains unchanged during the ripening process. Unripe bananas are characterized by their high starch content, their astringency, and lack of sweetness. The ripe fruit, on the other hand, has little starch and is not noticeably astringent. It is claimed that this astringency is due to tannin in the unripe fruit which is in the soluble form. As the fruit ripens the tannin becomes insoluble, or "fixed," and hence cannot be tasted in the ripe fruit.

Pectin

Pectin is usually classed with hemicellulose and cellulose as an unavailable carbohydrate.

The total pectin content of the banana is not great (about 1 per cent of the fresh pulp) but what relation this substance bears to the digestibility of the fruit is not very definitely known.

That the buffer action of the pectin plays only a minor part in the therapeutic action of apple and banana diets is proved by buffer curves. However, certain workers have given credit to the pectin of bananas and apples for the beneficial action of these fruits in the treatment of diarrhoea of both children and adults. The galacturonic acid content of pectin has naturally been assumed to have a detoxifying action similar to glucuronic acid. Other authorities find that no utilizable carbohydrate is derived from pectin by diabetic dogs, but that there is an antiketogenic action which indicates that pectin is not as unavailable as has been assumed. Some authors suggest that the resistance of banana-fed rats to orally ingested *B. enteritides* may be due in part to the pectin content.

Latex

When the peel of a green banana is punctured, a sticky, milky fluid oozes from the wound. This substance very closely resembles chicle.

Vitamin

Bananas contain fair amounts of vitamins A, B, C, G, and also some E. It is an excellent source of

vitamin A, a good source of vitamin B, but deficient in vitamin D.

THE VITAMIN TABLE FOR BANANAS

Vitamin A	+ to + +
Vitamin B_1	+
Vitamin B_2	+
Vitamin C	+ +
Vitamin D	low
Vitamin E	+ +
Vitamin G	+ +

+ signifies that materials contain the vitamin;

+ + it is a good source of vitamin.

The following figures indicate vitamin rating for bananas:—

	per ounce. Units International.	per ounce. Units Sherman.	Sherman Units. per banana.	per lb. of bananas.
A	71 to 95	400	360	1600
B	4 to 5	8	..	..
C	57	5	20	80
D	..	..	..	..
E	..	..	..	..
G	..	10	35	160

Eighty-seven grams of banana yield about 250 units of vitamin A; 270 grams yield about 50 units of vitamin B (B_1). A similar quantity of banana gives about 30 units of vitamin C.

According to a table furnished by Jung 100 gms of banana contain 10-20 units of vitamin B_2. The vitamin C content of foodstuffs was calculated on the basis of guinea-pig units. Tillmann's table records 30 units for 100 gms of banana. Expressed in milligrams per 100 gms. of fruit, the vitamin C content of the banana is 2 milligrams per cent as opposed to 2.10 milligrams per cent with Tillmann's method.

György found a vit[illegible] H, the lack of which is apt to produce cutan[illegible] affections similar to seborrheic eczema. A special minimum substance was discovered which cured this affliction in the rat within two or three weeks. This substance is named H factor, and the daily curative dose present in the banana is 4 to 5.0 gms of fresh fruit.

The following figures are given showing the contributions to the diet of the banana, orange and apple (medium size):—

	Cal.	Pro.	Ca.	P.	Fe.	Vit. A.	Vit. B.	Vit. C.
Orange	0.8	0.5	3.1	0.7	0.6	1.4	2.1	92.0
Banana	1.0	0.5	0.4	0.7	1.2	3.6	1.0	17.0
Apple	0.8	0.2	0.4	0.4	0.8	0.7	1.2	10.4

The above figures represent "shares":—

1 Energy share = 100 calories.
1 Protein share 2.5 gm. or 10 calories.
1 Calcium share — 0.023 gm.
1 Phosphorus share — 0.044 gm.
1 Iron share = 0.0005 gm.
1 Vitamin A share = 100 Sherman Units.
1 Vitamin B share = 30 Sherman Units.
1 Vitamin C share = 1 Sherman Units.

Being rich in vitamin A, bananas help normal tooth development, are a dietetic factor in regard to the length of life. Experiments with young rats have shown that the disease preventing, or healing, component of the A-vitamin in the banana is very active, while the components which increase weight act rather more slowly, but are present in sufficient quantity. The daily dose for an experimental animal was 1 gm. banana per 50 gms. body weight. With a child of three years, whose weight is about 12-14 kilograms, the daily banana intake should be 240-280 gms or 4-5 bananas. Considerably smaller quantities, however, ought to be sufficient.

Banana and Milk

Combined with milk, banana produces an almost completely balanced ration. Milk is also a good source of Vitamin A. Bananas and milk offered a means for measuring the effect of increased intake of vitamin A obtained from natural food sources. While the fat content of the banana is negligible as a source of calories, it is important as a holder of the fat soluble vitamin A. Milk, although the most important and satisfactory article of food for growing children is far from a complete food. It is markedly deficient in carbohydrate. Furthermore, pasteurization destroys the important vitamin C.

CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF BANANAS

Thus, it is necessary to supplement vitamins from other sources.

The following table shows how the addition of banana restores to pasteurized milk its vitamin values with increase of vitamin C:—

	Vitamin A.	Vitamin B.	Vitamin C.
Milk (Whole) ..	**	***	*
Milk (Pasteurized) ..	****	**	..
Milk (Pasturized) with banana ..	*****	***	**

Eddy and Kellogg state that the banana has about the same vitamin B value as tomato juice. Comparing the dry weights of materials, orange was found to contain one-fifth as much vitamin B_1 as yeast; tomato slightly less than one-tenth; banana one-twentieth, and apple still less. Orange, tomato and banana were found to be just less than one-tenth as rich in vitamin B_2 as yeast. The addition of vitamin B to the diet in the form of banana may cause a prompt and striking improvement of persons suffering from celiac disease.

Bananas, Orange juice and tomato juice are very rich in vitamin C. Patients suffering from chronic ulcerative colitis are given one very ripe banana, ½ glass of orange juice, 2 tablespoonfuls of vegetable purée, daily.

Lewis concludes that with a basal diet adequate in all respects except vitamin C, 10-15 gms. of raw banana per guinea-pig per day sufficed for growth and protection against scurvy. Givens, McClugage and Van Horne cosidered 10 gms. to be the minimum protective dose and the same amount was reported by Jansen and Donath for two varieties of Indian bananas. Eddy considers 5 gms. of banana to be the minimum protective dose, and 8-10 gms. the optimum dose for growth stimulation as well as scurvy prevention in guinea-pigs. Bananas baked with the skin retain their antiscorbutic properties better than when baked without the skin, probably on account of the protective action of the skin against oxidation. Eddy and Kellogg reported the cure of scurvy in eight months' old baby by a banana milk mixture made by whipping 200 gm. of ripe raw banana into 570 c.c. of milk. This was fed in 120 c.c. portions every four hours with no resulting digestive disturbances. Ripe bananas or if cooked when partially ripe are readily digestible even by infants, and are valuable in modifying infant milk formulæ because of the unique combination of readily assimilable sugar and vitamin C, and are an aid against constipation. Experimental results showed that the smallest amount of banana which keeps guinea-pigs (300 gms. weight) from developing scurvy, is 40 gms. a day.

There is no reason to assume that artificially ripened bananas are less rich in vitamin C than those which are almost ripened entirely on the tree.

Göthlin believes that the lowest protective quantity for prevention of scurvy for twenty-four hours would be present in 140-200 gms. of either apples or bananas in a raw state.

Only 5 gms. of yellow banana are adequate to prevent scurvy in guinea-pigs; this however, is not true in the case of red and green (the particular variety grown in India which retains a green skin when ripe) bananas. Ten gms. at least of red banana pulp were required for the purpose, while in the case of green banana pulp even 15 gms. proved insufficient.

Evans, Herbert McLean and Burr report that one third of a banana daily, averaging 27 gms., when consumed *ad libitum* separately from the basic ration, bestowed fertility in cure experiments. In describing their animal experiments the authors report that three rats were reared on a modification of the basic ration and that after sterility was proved in each case by the occurrence of a resorption gestation, they were fed daily apart from the basic ration, fresh crushed banana *ad libitum* (the animal consumed about 27 gms. of the fruit daily). They were then bred to males of proved fertility, a normal gestation resulting in each case.

Effect of Taking Unripe Bananas

Inasmuch as bananas are commonly eaten uncooked, it is obvious that more or less starch will be ingested, if the fruit is not ripe, *i.e.*, if the skin has not begun to shrivel and darken. Raw starch may be singularly irritating to the alimentary tract

of man and is at best poorly utilized, whether it be ingested in the form of uncooked potatoes, chestnuts, bananas or other native starch foods. No one would advise the use of uncooked potatoes; yet many people eschew a throughly ripe banana in the belief that this wholesome fruit is rotten when the skin becomes darkened, whereas they eagerly eat the yellow green starch bearing fruit at the stage of incomplete ripeness. Green bananas, like green apples, are unwholesome so long as the starch has not been adequately converted into sugars in the ripening process. The delicious and innocuous ripe banana should not be made to suffer in its dietetic reputation because of the ignorance of the consumer.

Besides taking in the raw form bananas are often baked and cooked, powdered and mixed with various vegetables, fruits and food of animal origin. These have got their particular degree of efficacy in increasing or decreasing the nutritive value and digestive property of the food produced. It will be too elaborate to deal with all these points here and probably a vast field of experimentation is still unexplored in this direction.

Extensive research work on banana therapy has been already published and it has been found that banana is very effective in combating scurvy, dysentery, diarrhoea, diabetes, kidney troubles and many other diseases.

From what has already been said it can be concluded that banana is a cheap fruit, available at all seasons, palatable, nutritious, easily digestible and of high therapeutic value.

Recent Advances in the Study of Plant Growth Hormones

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THE conception of a growth hormone can be traced as far back as 1882 to the work of Sachs, who suggested that leaves form "Organ-forming substances" and that plants contain specific substances which control the formation of roots. The conception has rapidly developed in recent years and the role of growth hormones in the growth of plants and root formation has been clearly demonstrated and a large number of synthetic organic compounds have been investigated which influence markedly the growth of plants. They are termed under the general name Auxins. Kögl[1] with his co-workers has been able to seperate, purify and determine the chemical composition of α-auxin $C_{18}H_{32}O_5$; β-auxin $C_{18}H_{30}O_4$; and heteroauxin $C_{10}H_9O_2N$, *i.e.*, β-indolyl acetic acid. They all have a similar effect on the stretching phase of the plant growth. Avery and co-workers[2] have added indole acetic acid, potassium indole acetate, indole butyric acid, potassium indole butyrate, naphthalene acetic acid, potassium napthyl acetate, and indole propionic acid as growth-promoting substances. Snow[3] has added benzoyl oxide and benzoyl peroxide. Crook, Davis and Smith[4] have reported β-thionaphthene acetic acid to be effective in concentration greater than one part in 70,000.

It has been shown that pure auxin prepared by Kögl and co-workers is active in root formation (Thimann and Went, 1934).[5] Out of the above-mentioned substances the effectiveness of β-indole acetic acid in root formation has been shown by

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Laibach,[6] Thimann and Koepfli,[7] and Fischnich.[8] In addition to a number of synthetic substances, Hitchcock and Zimmermann[9] and Pearse[10] have shown that indole butyric acid and α naphthalene acetic acid are very effective in root formation.

Quantitative Test

Standard avena test (Went,[11])—It is known that a growth hormone, when applied to the stump of a decapitated Aven coleoptile, moves downwards into the plant tissue and causes the longitudinal growth of the coleoptile. But when applied to one side only, it causes a lateral growth on that side alone, which results in a curvature on the other side, *i.e.*, negative curvature. On the basis of this behaviour Went formulated his technique of auxin test. Oats are germinated in a dark room at 25°C and 90 per cent humidity. When the coleoptiles have grown to about 3 to 4 cms. in length, they are decapitated, about 0·5 cm. of the coleoptile tip being removed. Standard size agar blocks are prepared in which the growth hormone is allowed to diffuse from the material to be tested for the hormone. These agar blocks are then placed unilaterally to the decaptitated avena coleoptile for tests. After a time the curvatures are photographed and measured. It has been found that the angle of curvature under certain limits is proportional to the concentration of the hormone present[11, 12, 13]. An automatic Photokymograph has been described by Schneider and Went[14] to record the curvatures.

The standard method is modified by Van der Weij[15] who introduced a second decapitation one hour after the first to prevent further regeneration of auxin. Skoog[16] modified the standard test by removing the entire seed after two days of germination, with the exception of the lower half of the scutellum. He has suggested that by this deseeded method the possibility of regeneration of auxin-precursor in the seed is prevented and a more sensitive test plant is obtained.

Pea test method (Went 1934)[17]—is also based on curvature method. Here stems of etiolated *Pisum sativum* seedlings are obtained. 5 cm. of the tip of stem is removed and then 2 to 20 cm. long pieces are taken and split longitudinally at the tip for one to three cm. The two halves of the split portion curve outwards in aqueous solution; but in presence of auxin and at 25°C and after about half an hour the two halves begin to curve inwards. This test can be made quantitative by using a series of concentrations and finding the minimum concentration when the action just begins.

A test method for Rhizocaline, described by Went[18] is based on the formation of roots in treated and untreated decapitated shoots of *Pisum sativum*. The stem is prepared by cutting the shoot when it has reached a height of 10 to 15 cm. germinated under controlled conditions of light and temperature. The first leaf appears under the third node and it is decapitated just below it. Thus a piece of stem is obtained containing the second and the third internodes. The base of the stem is then kept in water for four hours and then in 0.05 per cent potassium permanganate for four hours to free it from naturally occurring rhizocaline. After washing it free from potassium permanganate the apical portion is split longitudinally and then placed for 12 to 15 hours under standard conditions in rhizocaline solution. After rinsing the tip in water the base is supplied with a 2-percent sucrose solution for six days and then with tap water. After all this treatment the number of roots produced are counted 14 days after the treatment with rhizocaline. The rhizocaline unit Went described as the quantity of the substance which produces one root in excess of that produced in untreated control ones.

Sources and distribution

It has been demonstrated by various workers that terminal and lateral buds, cotyledons and leaves are among the most important sources of auxin. Thimann and Skoog[19] on *Vicia faba*, Uhrova[20] on *Bryophyllum*, Avery[21] on *Nicotiana*, Dollfuss[22] on *Podophyllum*, Goodwin[23] on *Solidago* and Avery and Co-workers[24] on *Aesculus and Malus* have shown the presence of auxin in leaves. The amount of auxin and its diffusion from the leaves is correlated with the age of the leaves. Diffusion is very small in early stages, then increases to a maximum which is coincident with the rapid growth of the leaf and then falls off with maturity. The concentrations of growth hormone at different periods in the life cycle of *Zea mays* have been studied by Laibach and Meyer.[25] Zimmermann[26] (1936) has studied the concentration of growth

hormone is several woody species. The presence of growth hormone in stem is not yet definitely known.

Studying the distribution of growth hormone in the coleoptile and radicle of Avena seedlings Thimann[27] has found the presence of growth hormone in appreciable quantity in the lower part of the coleoptile. The concentration decreases regularly from the tip to the base from 0.69 units to 0.19 at the base. The same is the case with the root, falling from 0.43 at the root apex to 0.26 in the physically uppermost region of the root. Root-forming hormone has been obtained from rice polishing, urine, wheat embryos and from leaves of *Helianthus Prunus and Malva* (Thimann and Went).

The presence of growth hormone in shoot tips is associated with growth and light. There is a close parallelism between growth intensity and growth hormone concentration (Zimmeramann).[26] Growth hormone is detectable in increasing amount during the swelling of terminal buds of *Aesculus* and *Malus* (Avery, Burkholder and Creighton).[24] Elsewhere Avery and co-workers[27] have demonstrated the disappearance of growth hormone in darkness and in depleted food supply. The plants under normal day and night conditions but under reduced CO_2 supply also form smaller quantities of growth hormone. Under reduced CO_2 but in continuous light of defferent intensities, growth hormone production is proportionately greater in higher intensities of light. Higher growth substance concentration is found under exposures of red and blue part of the spectrum.

Transport

It has been known from a long time in ringing experiments root formation takes place at the upper end of the ring supporting the view that the root forming substance travels downwards in the phloem from the apical region and accumulates at the upper end of the ring. In all cases of auxin it is found that auxin travels downwards from the apical region even in cases where initial auxin concentration in the basal part is three times that in the upper (Van der Weij).[28] So transport is here independent of the concentration gradient. Olson and Buy[29] reported that a growth substance is present in the egg cells of *Fucus* and plays an important part in its polarity. In relation to the seasonal activity of Cambium to growth hormone (Snow)[3] a concentration gradient has been observed. Pearse[10] also observed a concentration gradient effect and root formation throughout the length of *Salix vitellina* (Willow plant) cuttings when indole butyric acid in lanolin was applied at the apical portion, the number of roots gradually decreasing from apex towards the base.

Function of Auxin

Auxin plays a decisive part in the stretching growth of stems, apical swelling and root formations. But an inhibitory action in the case of lateral buds of *Vicia faba* has been noted by Thimann and Skoog[30],[19] and Skoog and Thimann.[31] They have found that auxin formed in the apical buds is responsible for the inhibition of the lateral buds. When the apical bud is removed and agar block containing auxin of the same concentration which would have been present in the apical bud, is applied, the lateral buds are also inhibited. Growth hormone is associated with lateral buds only when they are in active stage of growth. When the lateral buds grow and produce auxin it is found that adjacent buds are retarded in their turn. The significance of this inhibitory action is discussed later under the nature of auxin reaction.

As many workers, Priestly,[32] Wight,[33] Brown,[34] have shown that resumption and seasonal activities of cambium is closely associated with bud development, it is therefore to be expected that in addition to other factors, growth hormone may play a definite role in the activation of cambial activity. It has been demonstrated that the cambial activity is initiated at the level of the terminal buds in the spring and spreads basipetally. Along with this is also observed a gradient of hormone concentration down the stem (Snow).[3] The hormone produced in the expanding buds move basipetally in stems before there is any indication of cambial cell division. Hence it is probable that growth hormone initiates cambial activity.

Nature of Auxin Reaction

Much cannot be said on the mechanism of auxin reaction in relation to the incidence of growth in

plants. That is of a very complex nature is undoubtedly true, consisting of a chain of reactions brought about by more than one factor. The view of the stimulatory nature of auxin is advanced by Fitting.[35] It is said to cause the liberation of energy in the system. But the evidence obtained from a detailed study of auxin behaviour is against it. It has been found in almost all cases of growth substance that per mol. they all cause the same amount of growth under strictly comparable conditions. It leads therefore to the conclusion that the reaction is of a chemical nature where auxin molecules take part (Went),[14] and not of a stimulatory nature. Went[11] gave the idea of a second factor—" Zellstreckungs-Material " *i.e.*, cell stretching material supplied by the roots and moving from the base to the apical region, which is necessary for the auxin reaction. Laibach[6] and Skoog[16] also held the opinion of a second factor to which they suggested the name of auxin precursor. Therefore it is suggested that a second factor is necessary for the auxin reaction and auxin alone cannot cause the elongation of stem or swelling of bud and root formation. In connection with this food factor the interdependence of auxin and sugar for growth has been shown by Schneider[36] Went[14] and the role of salts in the response of Avena cleoptile to auxins has also been pointed out by Thimann and Schneider.[37] The food factor or auxin precursor, whatever name we give it, is not a simple factor, but a very complex one and sugar is a very important component of this food factor complex. Schneider demonstrated that for sub-optimal concentration of sugar and auxin, an increase in concentration of either gives an increase in the growth rate and its magnitude is proportional to the products of the logarithms of the concentration. Sweeny and Thimann[38] working on the effect of auxins on protoplasmic streaming have shown that low concentration of auxin (which is capable of growth acceleration) also accelerates streaming; but in higher concentration and in presence of limited oxygen supply it is retarded. They suggested that in the system an oxidative process is accelerated by auxin which controls the rate of protoplasmic streaming. As protoplasmic streaming is associated with growth, it is probable that it controls the growth rate and the substrate for this process is probably sugar. They held the view therefore that in auxin induced reaction the effect on protoplasmic streaming precedes that on growth. Similar view is put forward by Bonner[39] (1933, 1936) that the action of growth hormone in *Avena* coleoptile depends upon a process of respiratory nature though of a relatively small magnitude.

Recently Went[14] explained the auxin reaction on a double factor scheme. He suggests that the action of auxin is of secondary nature, depending upon independent specific factors. These factors he names Calines which are of hormonal nature and are formed and stored in one part of the seedling and are effective in another part, eg. caulo-caline (factor for elongation and swelling) is formed in the roots and cotyledons have only a small storage; phyllo-caline (leaf growth factor) is stored in cotyledons, but is also present to some extent in stem. Went has demonstrated the presence of these calines by decapitating different parts of seedlings (removing the sources of calines) and found deficient growth of these parts even in presence of auxin. So auxin is effective only in presence of these calines. The relation of auxin to different calines is not clear, but the relation of auxin to rhizo caline and caulo-caline is clearly demonstrated by experiments. Thus the root formation at the base of lemon cuttings (Cooper)[40,41] and in Willow cuttings (Pearse),[10] when auxin is applied at the apex is due to the accumulation of rhizocaline at the base of root formation. So the auxin gradient in the stem causes an accumulation of rhizo-caline which is responsible for root formation. Auxin therefore only brings about a redistribution of root forming hormone.

The phenomenon of inhibition of lateral buds observed by Timann and Shoog is explained on this basis of redistribution of caulo-caline by auxin. If auxin produced in the apical buds causes caulo-caline to move upwards in the stem and to accumulate at the place of auxin production, that is, apical buds, then the lateral buds which do not get caulo-caline cannot grow. But when apical buds are removed the lateral buds with their slight auxin production can direct caulo caline and begin to grow. The close relation between sprouting and root formation is also therefore evident (Cooper).[41]

On the assumption of this second growth factor, Calines, it is possible to explain some of the observed facts; but the modification in Went's view from Zellstreckung-Material to food factor and recently to calines of hormone nature, shows that much more experimental work on this aspect is needed before an analysis of the different processes induced by auxin can be appreciated. The association of auxin with active growth, the rate of which is controlled by a set of internal and external factors is a complex physiological process and to explain such a system by assuming the presence of another set of hormones, the existence of which we cannot at present directly prove, are problems which obviously require further investigation and elucidation.

Summary

1. Many synthetic substances have been added to the list of growth hormones. Modified Standard Avena Test has been recommended by having a second decapitation one hour after the first. It is also suggested that a deseeded seedling gives a more sensitive test plant.

2. Auxin is always associated with growth, and is formed and stored in one part and is effective in another part. The terminal buds, the lateral buds, the cotyledons and leaves are amongst the most important sources of auxins in plants. The amount of auxin and its diffusion from the leaves is correlated with the age of the leaf.

3. Auxin always moves basipetally down the stem from the apical region even when the initial concentration at the base is higher than that of the upper part. While moving downwards it forms a concentration gradient.

4. The association of cambial activity and bud development suggests the possibility of the influence of hormone in cambial initiation in the spring.

5. The nature of auxin reaction has been recently explained by Went on a double factor scheme. He suggests independent specific factors of hormone nature, naming them different Calines responsible for stem elongation, bud development and root formation and auxin playing a secondary role in diverting and redistributing these calines in plants. On this basis the formation of roots, the inhibition of the lateral buds by auxin and the close relation between sprouting and rooting have been explained.

6. It seems on the basis of our present knowledge that auxin induces a chain of reactions in a system where many internal and external factors play part and it has been demonstrated that sugar at least is one of the necessary components of such a system.

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The Nature of "Agaru" Formation

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Agaru is collected from trees of *Aquilaria agallocha* Roxb. (Nat. Order *Thymelæaceæ*), which are sparingly distributed in Assam-Garo Hills (Tura), Sibsagar, Sylhet, Tipperah Hills, Bhutan and Martaban Hills (Burma). Healthy trees of *A. agallocha* do not bear *agaru*, the *agaru*-bearing tree has a distinct diseased appearance at the top and in the side branches, and *agaru* is collected in quantity only when such tree is either completely or partially (*i.e.*, branches, top etc.) killed. It is the opinion of local Garos who work with *Agaru* that the tree producing *agaru* ultimately dies, and as a matter of practice, no tree is usually cut or felled unless it shows outward signs of disease. But sometimes by mistake they cut and destroy a number of healthy trees suspecting *agaru*-formation; thus, the number of trees in the forests, which are limited and usually grow at distances from one another, is being gradually reduced and there is no regular plantation to increase their number. I learn that recently a nursery of about 100 shrubs has been raised. In a tree *agaru* is usually found in forks or at the junctions of branches with the stem. The disease usually takes some time to make itself manifest, hence *agaru* is hardly found in young shrubs. *Agaru* is highly prized in the market, true *agaru* is sold at Rs 16 to Rs 20 per seer, at present it is a chance product as no means of artificially increasing its production are yet known.

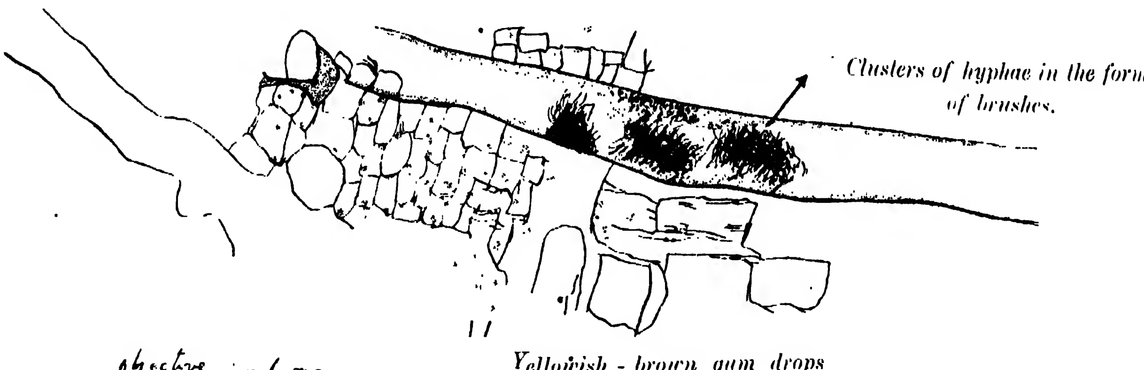
Dr Hooper, late Reporter on economic products of India, has recorded in the *Agricultural Ledger*, 1904, No. 1 that the wood of *Aquilaria agallocha* under certain conditions becomes gorged with a dark resinous aromatic juice and that the portions thus impregnated constitute the commercial *agaru*, which is esteemed in proportion as it abounds in resinous matter. The average yield of a mature tree is 6 to 8 lbs. and an exceptionally good tree may afford as much as Rs. 300 worth of *agaru*. The exact cause of its formation has not been ascertained yet.

Some years back in 1925 at the instance of Mr F. Trafford, the then Conservator of Forests of Assam, I began investigation of *agaru* wood; samples of wood from different localities and local information about *agaru* were sent to me from time to time by late Mr B. Sen Gupta, Mr J. N. Das, Dr N. L. Bor, Mr C. J. Rowbotham, Mr C. G. M. Mackarness, Mr W. R. Martin, Mr A. R. Thomas and other officers of the Forest department of Assam. On enquiry I learnt that the Bengal Chemi-

cal and Pharmaceutical Works of Calcutta get their supply of *agaru* wood from Sylhet (village Sujanagore). Sections of the diseased wood showed drops of yellowish-brown gum almost in every cell, a fungus-mycelium was found close to the clotted areas where there was a massive accumulation of gum-drops; in the cavities produced by the disintegration of wood-elements there were clusters of thin and narrow hyphae here and there in the form of brushes (fig. 1). Sections were cut from successfully grown in artificial medium (malt-extract agar) and its complete life-history was studied; it belongs to the group of ***Fungi Imperfecti.*** A short account of the investigation was communicated and read at the Bombay sitting of the Indian Science Congress in January 1926, it has been published at p. 224 of the *Proc.* 13th. Ind. Sc. Congress. Inoculation-experiments to produce the formation of *agaru* in healthy trees by this fungus-attack could not be carried out for want of *A. agallocha* trees in Bengal; some seedlings were imported from Assam and planted in our College-

Agaru Fungus—Hyphae

Fig 1.



objective :- 6 m.m
Eye piece :-(x 10)

various parts of pieces of *agaru* wood from different localities and in each case the same fungus with closely septed hyphae of dirty-brown colour could be traced. The wood of the clotted areas showed delignification by patches (fig. 2), dark and white layers regularly alternating. The general effect on wood agrees in all particulars with that produced by wood-destroying fungi on timber-trees (*c.f.* A. S. Rhoads, New York State College of Forestry, Syracuse University, *Technical Publication*, no. 8, vol. XVII March 1917 and D. V. Baxter Pap. *Michigan Acad. Sci*, Vol. III-1923). The fungus was

FIG. 2.

Objective—no. 7 of Leitz eye-piece— (×10).

Long. Section of the Agar wood showing delignification, septed hyphae represented in deep-black.

Garden but they did not thrive well and ultimately succumbed. Pure cultures of the fungus were from time to time sent to the forest-officers of Assam (Garo-Hills, Sibsagar, etc.) for inoculation on trees in their vicinity, but they could not satisfactorily proceed with the work. For the ultimate solution of the problem a number of trees should be available close to our place. It is very encouraging that the present Superintendent of the Royal Botanical Garden, Shibpur, Dr K. P. Biswas, is trying in right earnest to grow some plants from Assam in his garden and also at Mungpoo Cinchona-plantation for my work with the kind help of the Conservator of Forests, Assam and Mr A. Das I.F.S. (retired) now working at Shillong on "Flora of Assam.' Of course, it will take a number of years hence before they are fit for the inoculation-stage.

Records of the Royal Society of London

THE Booklet, *Notes and Records of the Royal Society of London*, No. 1, April 1938, published by the Royal Society of London replaces the former publication of the Royal Society, titled *Occasional Notices* which described the activities of the Society, because it was felt that 'such a periodical might usefully include information of historical interest which would not be printed in either *Philosophical Transactions* or *Proceedings*.' It will be issued in April and October of each year, the former number being devoted to an account of the Anniversary Dinner, elections to fellowship and general information relating to the winter half of the session and the latter to an account of the two soirées and general information relating to the summer half of the session.

The *Notes and Records* will prove to be of considerable interest to those who have passed through the last four years' thrill of Academy-building in India. The information that it seeks to give is divided into 21 heads. It includes a list of the 20 new fellows elected on March 7 and also one of those among the fellows who died during the year (15) Last year's loss to the Society due to the death of its fellows was specially severe in view of the passing away of such eminent scientists as Lord Rutherford, Sir J. C. Bose and Dr G. E. Hale.

The society received during 1937 about £6116 in cash and the residuary estates of the late Dr J. H. Stothert and E. T. Browne as bequests. It is announced that the Pilgrim Trust has endowed funds for six years for two annual lectures—one to be delivered in London by a Fellow of the National Academy of Sciences, Washington, and the other by a Fellow of the Royal Society in America, the object being to promote good relations between the two English-speaking nations. The first lecturer under this scheme is Dr Irving Langmuir of the General Electric Company, America.

In the Anniversary Dinner held on the 30th November the guest of honour, Sir Jhn Simon, in proposing the toast of the Royal Society, gave much valuable information about origin of the Royal Society. We learn that its beginnings were laid at a meeting of some enterprising men at the Wadham College, Oxford. Sir John described in picturesque language the three governing ideas of the Society.

It was some space after the end of the Civil Wars at Oxford, in Dr Wilkins his Lodgings, in Wadham College, which was *then* the place of resort for Vertuous and Learned Men, that the first meetings were made, which laid the foundation of all this that follow'd.

'Allow me, My Lords and Gentlemen, to remind you for a few moments of the remarkable character and achievements of Warden Wilkins. He preserved his position as the Head of the College both before and after the Restoration. He commemorated the Commonwealth by marrying a sister of Oliver Cromwell, but his latitudinarian views were found not to be displeasing to Charles II. He wrote a treatise to prove that the moon was habitable, and another one to discuss how

it would be possible to make the journey thither. He invented, and made considerable use of, a universal language. He wrote a learned work, as was appropriate to a future Bishop of Chester, to prove, from the dimensions given in Holy Writ, that Noah's Ark was big enough to contain all the animals on earth. Aubrey described him as "the principal reviver of the new philosophy at Oxford"—that is to say, natural philosophy pursued by methods of experimental science. And he had the extraordinary good fortune, when Head of this small College at Oxford, to have among his undergraduates a young gentleman named Christopher Wren — that universal genius who was mathematician, chemist, biologist and architect, all rolled into one. Associated with Wilkins, too, was that remarkable physicist the Honourable Mr Robert Boyle, whose portrait you see reproduced on the card of this Dinner.

'Let me read you a passage from Evelyn's *Diary*, under the date of 13 July 1654, which shows how solid and well-founded is the claim that it was within the walls of Wadham that this new learning was cultivated and pursued:

We all din'd at that most obliging and universally curious Dr Wilkin's at Wadham College. He was the first who shew'd me the transparent apiaries, which he had built like castles and palaces, and so ordere'd them one upon another as to take the honey without destroying the bees......He had also contriv'd an hollow statue, which gave a voice and utter'd words by a long conceal'd pipe that went to its mouth, whilst one speaks through it at a good distance. He had above in his lodgings and gallery variety of shadows, dyals, perspectives, and many other artificial, mathematical, and magical curiosities, a way-wiser, a thermometer, a monstrous magnet, conic and other sections, a ballance on a demi-circle, most of them of his owne and that prodigious young scholar, Mr Chr. Wren, who presented me with a piece of white marble, which he had stain'd with a lively red, very deepe, as beautiful as if it had been natural.

'In 1660 it was resolved at a meeting of twelve persons that Society should be formed "for promoting physico-mathematical experimental learning." That was in London, and the Society, of course, is the institution whose health I am proposing.

'So much for origins. And when one considers the achievements of this splendid institution, whose record now stretches continuously over two and three-quarter centuries, one may detect running through its work three governing ideas, which I venture to formulate to-night.

'First, your founders and those who came after them have held firmly by the doctrine that the business of the investigator is to pursue his experiment, wherever it may lead, without any regard to orthodox tradition.

'Secondly, from the very first down to to-day, this organized instrument for the pursuit of knowledge has been used by its members with no idea that scientific discovery would necessarily be of immediate practical utility, but because the truth is worth finding out for its own sake. And as a result, to a perfectly incredible degree, these new discoveries have in fact been found to contribute immensely to the benefit of mankind. Names such as Davy, Kelvin, Rayleigh—and another name which stirs in us a poignant feeling to-night, the name of Rutherford—to mention merely these instances, have established that claim for the Royal Society for all time.

'And thirdly, the practice and precept of this Society embody the great principle that it is by the interchange of scientific ideas between scientific men of different kinds that progress is best achieved, notwithstanding the intense specialization of the age. I was interested to notice, in looking through Thomas Sprat's book, that he expressed this last view in these curious words:—

If I could fetch my materials whence I pleas'd to fashion the Idea of a Perfect Philosopher: he should not be all of one clime, but have the different excellencies of several Countries. First, he should have the Industry, Activity, and Inquisitive humour of the Dutch, French, Scotch, and English, in laying the ground Work, the heap of Experiments: And then he should have added the cold, and circumspect, and wary disposition of the Italians, and Spaniards, in meditating upon them, before he fully brings them into speculation. All this is scarce ever to be found in one single Man: seldom in the same Countrymen: It must then be supply'd, as well as it may, by a Public Council; wherein the various disposition of all these Nations, may be blended together. To this purpose, the Royal Society has made no scruple, to receive all inquisitive strangers of all Countries, into its number.

'Science has thus a special claim for the respect of those whose working life is largely concerned with public affairs. It is completely international; it speaks all languages and it knows no frontiers. It is capable of being an ambassador of peace and goodwill for the whole world.

'Literature—and I speak as a humble and devoted worshipper of the Muses—has often been the vehicle for national passions, and perhaps for national prejudices. Tennyson's *Maud* was published during the Crimean War,

and it cannot have been a contribution to peace to call the ruler of Russia "a giant liar" or to write the line: "And Jack on his ale-house bench has as many lies as a Czar."

'Art, too, has often been misused for purposes of national rivalry and ridicule. But the work of men of science in pursuing the truths of Nature is in its essence a contribution to the things which are capable of binding together the nations of the earth.

'The Royal Society has a fine record in this respect. I recall two incidents in the history of your Fellows. In the middle of the Napoleonic Wars Davy was awarded by the *Institut de France* a great prize of 3000 francs. There were those in both countries who criticized either the award or its recipient. But it was a fine gesture that, when these two countries were locked in the conflict of war, learned men on the one side of the Channel gave honour to a learned man on the other. Davy himself claimed that the influence of a man of scientific reputation "can soften the asperities of national hostility." The other incident to which I would refer occurred when the Peace of Amiens suddenly broke down. At that moment there were many Englishmen travelling on the continent of Europe. Some of them were arrested by the French authorities as alien enemies and detained as non-combatants within the confines of France. They applied for their release. One of these was Edward Jenner. When Napoleon examined the list, it was the finger of Josephine who pointed to the name of Jenner, and Napoleon declared: "We can refuse nothing to that man."

'Great then are the contributions in the public and international sphere which it is in the power of men of science to make. May their contribution be used for the benefit and advancement of mankind, and not abused to add to the destructive powers of the world. I wish all that is good to this splendid institution, the most famous and ancient of its kind, not only because I have been brought up to reverence learning and to respect knowledge, but because the work which you, Mr President, and your Fellows are doing is capable of spreading peace among the nations of the earth.'

The President of the Society, Sir William Bragg, in replying remarked:

'Sir John has spoken of the part which Science may play in drawing the nations together and so contributing to the peace of the world. The relations between knowledge and the unity of mankind are indeed most important. It is well to draw attention to them. Long ago the Greek philosophy held that knowledge and the exchange of knowledge differentiated the reason of man from that of the animals. The exchange was essential; success in the pursuit of knowledge was a social matter. A modern writer[1] has reviewed the question in the light of the events of the thousands of years that have elapsed since then. He has observed that there is a certain correspondence between the period of maximum scientific activity and maximum realization of unity. Thus the Greek construction of science and philosophy may be connected with the formation of the Greco-Roman world, at the head of which were men trained in Greek philosophy attempting to apply the rules of reason to an accumulation of sociological knowledge. Again, the revival of science in the fifteenth and sixteenth centuries is allied to the discovery of the New World and the expansion towards the West. And once more, towards the end of the eighteenth century the rapid increase of science led to a new linking up of the world eclipsing all that the earlier centuries had to show.

'The question, however, which most nearly concerns us is this: Does the increase of knowledge of Nature bring about that unity which makes for peace? No doubt it brings the nations together in the sense that they become more aware of each other, that their intercommunications have increased, and that they trade with each other more freely. But do jealousies and hatreds and causes of conflict disappear? I am afraid that history shows no such happy result. Was there ever a more quarrelsome set of little States than those that grouped themselves about Athens and Sparta? Did Europe settle down to peace when after the Renaissance experimental methods expanded the knowledge of the natural world? The eighteenth and nineteenth centuries were full of war in spite of their scientific activities. And worst of all, since the last great war, though natural knowledge has grown astonishingly, the present world is seething with unrest; both in Europe and in Asia bitter wars are in progress. The clouds overhead are dark and heavy.

'Yet I think that if we look at another part of the sky we can see rifts in the clouds; and the wind is blowing from that direction.

'Let me define the position as it appears from another point of view.

'Man, they say, has raised himself above the beasts by his success in making tools, which have given power to his hands, and opportunity for the development of their skill. Much later came the sharpening of his senses due to the construction of instruments of observation, and the consequences have been and are tremendous. First came the measuring instruments of the old astronomers and geometers on which Greek and Egyptian science was based. These gave accuracy in the comparison of angles and distances, and through astronomi-

[1] F. S. Marvin, *Studies in the History and Method of Science*, edited by Charles Singer.

cal observations a certain knowledge of the passage of time. From these the knowledge of the natural world derived its increase for more than fifteen hundred years.

'Then towards the end of the sixteenth century came the microscope and the telescope, the pendulum and the thermometer, and science leapt forward with powers vastly increased. The telescope set far back the bounds of the universe, and the microscope opened up a world of the very small hitherto beyond the powers of the unaided senses. The pendulum provided a convenient and accurate measurement of time and the thermometer an estimate of temperature which outclassed the natural capacities of touch and feeling. It is odd that the common use of single lenses for 300 years should never in all that time have led to the use of lenses in combination. Spectacles had been in use in Europe since 1300. There used to be a gravestone in a Florentine church which bore the quaint inscription: "Here lies Salvino d'Amarto degli Amarti of Florence, the inventor of spectacles. May God forgive him for his sins. He died Anno Domini 1317."[1] Bernard de Gordon, physician of Montpellier, in his *Lilium medicinae* (1305), mentions them in recommending his own eyewash which renders spectacles useless! In Holland, at about the end of the sixteenth century, Jansen invented the microscope, and shortly afterwards Lippershey was commissioned to make telescopes for military use.

'But it was Galileo who first made revelation of the immense powers of the new instruments. Following him came a long list of scientific workers of the seventeenth and eighteenth centuries who used their sharpened and strengthened senses in the building of a new experimental science. Early in the nineteenth century electrical and magnetic instruments came rather to add new senses than to improve the old. In recent years the X rays, radioactivity, the ionic valve, the cloud chamber and other new instruments have furnished yet further means of observing the world in which we live. As a result the boundaries of that which is observed by unaided eyes and ears and other senses have been far overpassed; our familiar world has become but a spot in the middle of an expanse whose horizon is constantly receding.

'Now it is to be observed that the knowledge of this wider world and of its contents is of vital importance to us. Our interest in it is not merely academic. We live in it and are part of it. We are, so to speak, citizens not only of the town in which we have lived without acquaintance with what lies outside the town walls, but citizens also of a wider country. We know that we must obey the municipal laws. We now find that there are country laws, of which we have had no knowledge hitherto, and these also must be obeyed under penalties which may be of the utmost severity. Indeed we have in the past suffered heavily because we have unwittingly broken them. If this seems to us unjust, it must be remembered that in our ignorance our judgment is of no value. Moreover the country of which we are now aware is full of resources, which we can gather according to our powers, and use according to our will.

'We are in a continuous state of adjustment to the conditions in which we find that we are living. We cannot shut ourselves within the town walls and refuse to look outside. We must step out into the open, and this is in effect what men are doing. The more they do so, the more they forget the divisions and quarrels of the town, the more the nations find that they must act together. Consider the various activities of mankind at the present time and see what is happening.

'To begin with, there are the activities of the search for knowledge, inspired simply by the wish to know and understand without thought of application of what is discovered. In this the nations act as one body. In every branch of science, knowledge is fully interchanged: men from all nations meet continually in conference and speak in one language though their vocabularies may differ. As knowledge grows, conference becomes more frequent and the feeling of comradeship grows also.

'There are the vast subjects of medicine, surgery, hygiene. Here also is the same search in common: the same collaboration between the men engaged in it. The governments of the nations are now deeply concerned. What government would not gladly communicate to any other a discovery which made for health? Indeed, the health of the world becomes a matter in which all nations must take counsel together, framing laws to govern such matters as the spread of infection, the provision of remedies, quarantine and so on. The health of the animal world in land and sea, of the vegetable world, pests and antipests, all that concerns the production of food and other necessaries of life grow more and more international the more account is taken of the new knowledge.

'The same is true of the trade of the world. In all the complicated arrangements that the nations in council must make for the conduct of traffic on the seas and in harbour, for lighting, direction finding and other aids to navigation, for charting, for the examination of goods in transit, for transportation on land, an in very many other matters, the new knowledge permeates the whole business. The nations are obliged to act together, and they do so.

[1] Loc. cit. p. 399.

'Knowledge of the wider world has transformed the means of communication of intelligence, by mails travelling over land or sea or in the air, by telegraph and telephone, by wireless. The nations cannot use the new means unless they confer. Hence the many conferences, and the continued exchange of information, and the consultations of the directors of the various activities.

'The same is to be said of meteorology, a study which is based on observations of the modern kind, and is only possible when the whole world contributes to it in ways that are determined in a world council.

'Equally true is this of standards of weight and length and time, of illumination, of electrical and magnetic and many other quantities and qualities. Here again the various countries of the world must, and do, confer: and the information which they exchange is expressed in terms that the unaided senses cannot appreciate. So also the tests of materials that are used in the vast and varied constructions of the world must be determined by common action. In the spring of this year a great international conference assembled in London, at which these matters of world importance were discussed. It was notable that the discussions turned continually on observations belonging to the wider world of the aided senses, and it was the width and depth of the questions discussed that had brought the nationalities together.

'The point I would make is this, that modern science and modern applications of science are leading to a vast amount of international effort. The new knowledge of Nature is opening up activities of which man is eagerly making use: and the character of these activities is such that co-operation between the nations is necessary to success. As a consequence co-operation already exists, and is increasing. The old assertion is being fulfilled, that the progress of knowledge is a social affair, demanding co-operation and harmony. Knowledge of Nature in itself does not so much bring peace as the common pursuit of that knowledge.'

The *Notes* on the Foundation and History of the Royal Society will be of interest to those who have witnessed the National Academy Controversy in India.

We learn from this chapter that the Royal Society was one of the earliest practical fruits of the philosophical labours of Francis Bacon, who in his *New Atlantis* advocated the foundation of a Philosophers' College. On Sept. 22, 1641 there arrived in London, a celebrated (Czechoslovakian Philosopher, Jan Amos Komensky, better known as Comenius on the invitation of Samuel Hartlib, an influential citizen of London, and a friend of Milton. Comenius, who had been a bishop, but was expelled on religious grounds, had written a book "*Pansophic Prodromus* (Essay towards complete wisdom) which made a great appeal to the earnest-minded men of the times and was translated in several European languages. Hartlib in inviting Comenius ended with the words "Come, come, come: it is for the Glory of God: deliberate no longer with flesh and blood." Comenius met in London a number of prominent English Leaders, Pym, Selden, Lord Brooke, and others.

During his residence in London, Comenius explained his plans in a tract entitled *Via Lucis* which he described as

'a reasonable disquisition how the intellectual light of souls, namely Wisdom, may now at length at the approach of the eventide of the world be happily diffused through all minds and peoples.'

He further wrote

'It is hardly necessary to describe how indispensable a School of Schools or Didactic College would be, in whatsoever part of the world it were founded: even if there be no hope for the actual establishment of such a college corporations being left wherever they are, the design itself should be cherished with a holy faith among the learned, pledged as they are, to promote God's glory in this very matter.' These men should make it the object of their combined labours to establish thoroughly the foundations of the sciences, to spread the light of wisdom throughout the human race with greater success than has heretofore been attained, and to benefit mankind by new and useful inventions. For unless we desire to remain ever in the same position, or even to go back, we must take care that our successful beginnings lead on to further advances. For this no individual, and no single generation sufficeth, and it is therefore essential that the work should be carried on by many persons, working in concert and using as a starting point the researches of their predecessors. This Universal College would bear the same relation to other schools that the belly bears to the other members of the body, that of a living laboratory supplying sap, vitality, and strength to all.'

On commenting on Comenius' part, Dr F. Young M.A. (Oxford), corresponding member of the Royal Bohemian Society of Sciences, Prague writes

RECORDS OF THE ROYAL SOCIETY OF LONDON

'The visit of Comenius to London in 1641-2 marks an important stage in the development in this country of the idea of a great institution for scientific research, which resulted in the organisation of the "Invisible or Philosophical College" by Theodore Haak and others in 1645, and the foundation of the Royal Society in 1662.'

The Invisible College which was the immediate precussor of the Royal Society was however no Pansophic University, carrying out the dreams of Comenius

It was merely a club of young men, some of the intelligentsia of that day, brought together by common college backgrounds and many common interests for rest and refreshment from the political, theological and military turmoil of the times.' The Invisible College (the name was first used by Boyle) included a small group of friends- Wallis, Wilvins, Goddard Ent, Scarborough, Glisson, Merrit, Boyle, Foster and Haak -whose ages ranged from eighteen to forty eight. Theodore Haak, a Calvinist refugee, had joined with Hartilib in welcoming Comenius to England in 1641: the other members of the group were none of them named by Comenius as his friends or patrons who were older men.

The history and constitution of election methods of fellows of the Society which proved to be a matter of some controversy, make a very interesting reading

Unlike the Academies of Science in most other countries where they exist, the Royal Society is not restricted by the terms its Charters in the number of candidates which may be admitted to the Fellowship. The selection and election of candidates is left to the absolute discretion of the President, Council and Fellows of the Society. The manner in which they have carried out this duty in the past is of special interest in studying the growth of the Society.

From its foundation the Society was absolutely dependent upon its own resources, for it had neither a subvention from the State nor were its publications printed by an official printing press, advantages which other national academies have usually enjoyed. The subscriptions of its Fellows and occasional gifts and bequests were all that the Council could look to for meeting the growing expenses of the young Society. The development of an adequate membership was therefore imperative, and long engaged the Council's attention.

The number of Fellows at the Anniversary 30 November 1663 was 131; this rose to 199 a few years later, and then fell off to 116 in 1691; by the end of the century there were 125 besides 37 foreign members. Admissions to the Fellowship during these years were on the average only nine in each year, and this was hardly enough to maintain the membership near its original figure, but with an average of twelve admissions in the decade 1701-10 and of eighteen in the next decade the membership began to rise. In these totals of membership and in those which follow the Royal Patron and Royal Fellows are not included.

About this time interest in the Society and its aims seems to have waned temporarily since in 1680, the attendance at the meetings was so meagre that the Society was in danger of being dissolved. Evelyn writes to Pepys begging him to attend the weekly meetings 'even if you cannot be there until 6 or 7 o'clock.'[1] Hooke, too, in his diary comments on several occasions on the meagre attendance. But things soon began to mend, and the election of Newton to the Presidency in 1703 may well have had considerable influence in bringing about the rise in the number of Fellows which occurred in the early part of the eighteenth century. The average number of candidates admitted to the Fellowship, which had hitherto been nine in each year, rose to fifteen for the twenty years 1701 20. For the remaining eighty years 1721 1800 the average was twenty-three; the number varying from 19.9 in 1751-60 to 25.7 in 1771-80. Consequently the number of Ordinary Fellows rose steadily from 121 in 1697 to 195 in 1721, 303 in 1741, 352 in 1761, 479 in 1781, reaching 545 in 1801.

Foreign members, who numbered 24 in 1697 and 37 in 1701, continued to increase in number as though the qualifications of such candidates were not scrutinized closely enough by the Council. By 1721 their number had risen to 64, and by 1766 to 170, or about half as many as the Ordinary Fellows of the Society in that year. By 1761 the Council felt that the Foreign Members, who then numbered 154, were becoming too numerous, and enacted a Statute providing that their certificates should be signed by at least three 'Foreign Fellows' as well as 'by three Fellows named in the Home List.' In 1765 Council further resolved that no Foreigner be proposed for election who is not known to the learned world by some publication or invention which may enable the Society to form a judgment of his merit; also that until the number of Foreign Members be reduced to eighty not more than two be admitted in one year. In the Statutes of 1776 the restriction of two elections a year is omitted, and ten years later the number of Foreign Members was limited to 100, which was altered to 50 in 1823. The result of this was that the number of Foreign Members in 1801 was 77 only, or about one-seventh of the number of the Ordinary Fellows of that year.

[1] Pepys, vol. ii, p. 337, by A Bryant.

At the outset scientific men had only constituted about one-fifth of the membership of the Society, the rest of the Fellows being drawn from the educated classes of the time and not necessarily from any of the learned professions. This continued to be the constant practice of the Society for many years so that its membership consisted, firstly, of men of science, and secondly, of those who from their position in society or their fortunes it might be desirable to include as patrons of science. The proportion of these two classes varied from time to time but it was not until the middle of the nineteenth century that the general principle was revised.

As the Society became more firmly esstablished and better known, candidates for election became more numerous. Throughout the whole of the eighteenth century there was a steady rise in the number of Fellows, which reached 545 in 1801; it continued to increase year by year until 1848. There is no means of analysing the membership at any point in the eighteenth century in order to determine what proportion of the Fellows were men of scientific standing, but the ready admission of others, most of whom apparently paid a composition fee of £40 instead of an annual subscription, suggests that those who were elected not for their scientific eminence alone were in the majority. To quote a single case: Sir Roderick Murchison, the geologist, was elected a Fellow of the Royal Society in the spring of 1826; for this honour, as the President, his old friend Sir Humphrey Davy, told him, he was indebted not to the amount or value of his scientific work, but to the fact that he was an independent gentleman having a taste for science, and with plenty of time and enough means to gratify it.[1]

Numerous pamphlets and other publications criticizing the administration of the Society appeared during the early part of the nineteenth century and from one of these the proportion of scientific Fellows to the rest can be deduced since the author gives an analysis of the communications from Fellows which were published in the *Philosophical Transactions*. Of the 662 Fellows who formed the Society in 1830 only 106 had contributed at least one communication which had been published in the *Philosophical Transactions;* and of this number 44 of them had contributed only a single paper.[2] The great majority of the Fellows, therefore, were doing very little to promote the advancement of Natural Knowledge.

[1] *A Memoir of Sir Roderick Murchison*, by A. Geikie.

[2] *The Royal Society in the Nineteenth Century*, by A. B. Granville, F.R.S., London, 1836, pp. 33—39.

This problem had long been before the Council and as early as 1674 'the ejection of all useless Fellows' had been proposed by Newton, but this raised too many difficulties. Many discussions, both in the Council and informally among the Fellows themselves, took place as time went on, and in 1831 the Council appointed a Committee to re-examine the whole question. The Committee reported that any alterations in the Charters would be difficult and expensive to carry out; and for this reason they recommended a revision of the Statutes by which six signatures of Fellows instead of three on the certificate of each candidate should be required; also that elections should take place only at the first ordinary meeting in December, February, April and June, instead of at any meeting. These remedies proved quite ineffectual; by 1834 it was found that four meetings did not suffice for carrying out the election of the candidates under the procedure then in use, and therefore this restriction was dropped. No reduction in the number of candidates had been effected, for the records show that 50 were elected in 1834; nor does it appear that any critical selection of those who were the most suitable for their scientific knowledge had been introduced. Moreover, during the forty years 1801 to 1840 the elections numbered 1081 while the deaths were only 776, so that the membership was still increasing steadily.

It may well be that the large number of Fellows who compounded for their subsriptions presented a financial problem of some difficulty. In 1847 there were 480 who had compounded as compared with 284 who were paying an annual subscription; and there is good reason to suppose that non-scientific Fellows formed the great majority of those who had compounded. If the average annual number elected was to be reduced from 27 as it then was, to 15 as had been suggested in 1846 and as was actually done in the following year, the Society's annual income might suffer to the extent of twelve composition fees of £40 each. This may well have caused Council to hesitate before taking such a step. In 1831 the Treasurer's report was printed and published in full for the first time, and in it we see that the receipts from composition fees from 27 out of 29 newly elected Fellows brought in £1080, while subscriptions for the year amounted to only £286.

In May 1846, in consequence of a proposal made by W. R. Grove, F.R.S., another Committee was appointed by the Council to examine and report upon the Charters and Statutes; they held several meetings and presented their report to the Council on 16 June 1846, together with a draft of new Statutes which included certain alterations proposed by the Committee. This report was considered by the Council at several meetings and was finally adopted on 10 February 1847 when orders

were given to print and circulate to the Fellows the revised Statutes. The two most important provisions were (i.) that the election of candidates for the Fellowship should take place once a year only, and (ii.) that the Council should select not more than fifteen candidates whom they cosidered suitable and should recommend them to the Society for election. During the discussions in Council amendments to replace the number 15 by 17, or by 20, were proposed, but the original number 15 was finally adopted. The effect of this was at once apparent; the admissions for the years 1841-47 had amounted in all to 176, or 25 yearly on the average; in 1848 and in the subsequent years up to 1930, 15 only were elected.

The Statute which, with two alterations made in recent years, has been in force until now, in no way alters the right of the Fellows, which is conferred on them by the Charter, to elect whomever they may please and as many as they please at a general meeting of the Society.

For the twelve months 1 December 1846 to 30 November 1847, the Membership of the Society included: Patron and Royal Fellows 13, Foreign Members 47, Ordinary Fellows who had compounded 480, Ordinary Fellows paying an annual subscription 284, so that the total number of Ordinary Fellows was 764. Numbers now began to fall steadily; in the twenty years 1848-68 the number of Ordinary Fellows had fallen by 218, and in the next twenty years, 1868-88, by 77, bringing the number of Ordinary Fellows to 469 in 1888.

It is instructive to note that this large reduction affected the list of compounding Fellows almost exclusively; while in 1847 those who had compounded numbered 480 and the annual subscribers 284 only, the corresponding numbers in 1868 were 289 and 257, and in 1888 they were 182 and 287. The total number of Ordinary Fellows has since then not varied greatly, but the annual subscribers have increased by about 120 at the expense of those who preferred to pay the composition fee which was at first £40, then £60, and is now £75.

This restriction on the number of candidates to be admitted annually to the Fellowship, and the demand for adequate scientific qualifications which was the natural consequence of it, constituted the most important change in the administration of the Society which had been made since its foundation. It changed it at one stroke from being an eminent body of cultivated men only a proportion of whom were devoting their lives to the advancement of Natural Knowledge to one in which the promotion of science was the first aim, and for admission to which a certain standard of scientific eminence was obligatory.

In 1875 a Committee was appointed by Council to consider 'whether it is desirable or not to make any alterations in the Statute relating to he Election of Fellows.'

They recommended that the duty of selecting the candidates should be left in the hands of the Council, and that the number to be selected and recommended annually to the Society for election should continue to be fifteen.

Since then, the number of candidates to be recommended for election in each year has been altered twice; it was raised to 17 in 1930 and to 20 in 1937, at which figure it now stands.

The membership on 30 November 1937 was made up of:

Patron and Royal Fellows	4
Foreign Members	50
Fellows	453

The number of Ordinary Fellows has only varied between 442 and 459 during the last fifteen years. It is of interest in this connexion to note that in the early years of the nineteenth century Dr W. H. Wollaston expressed the opinion that about 400 would be a suitable number for the fellowship.

The experience of England in organising her National Academy of Sciences (for the Royal Society of London is recognised as such by the British Government, in spite of the existence of other Royal Societies, Academies, and Societies devoted to particular subjects in the United Kingdom) will be invaluable to those in India who are now trying to organise the senior scientific men of India into a national body, capable of weilding sufficient influence amongst scientists as well as with the Governments.

Review of the Rockefeller Foundation for 1937

We have for some time past with us a booklet titled *The Rockefeller Foundation—A review for the year 1937*, by Raymond B. Fosdick, President of the foundation. It will be remembered that the late J. D. Rockefeller, who died at the age of ninety-eight on May 23, 1937, made gifts for philanthrophic purposes to the staggering amount of 530 million dollars, *i.e.*, nearly 160 crores of rupees in Indian money. The yearly income would appear to be nearly 7 crores of rupees, exceeding the total budget of the province of Bihar. The ways and means by which J. D. Rockefeller made his money were not, according to some critics, always clean and above board. The curious reader may turn to the lucid account given by H. G. Wells in his *Wealth and happiness of Mankind*. But if money was ever well-spent, here is the case!

It is estimated that since their foundation, the various Rockefeller foundations have spent nearly 665 million dollars, *i.e.* nearly 200 crores of rupees, for philanthropic purposes.

There ought to be a sound philosophy, and method behind all manner of charities, otherwise these may be entirely futile, as so many of them are in India. Infact, the late Mr Carnegie, whose charities came next to that of Rockefeller (400 million dollars), used to say ' It is more difficult to spend money than to earn,' and consistent to this maxim, he devoted the last twenty years of his life to the administration of the funds created by him, as the constitutional head. Let us therefore see what the philosophy behind the Rockefeller charities was and how the funds have been administered. We learn from the report

Mr. Rockefeller always made his gifts after thorough study and careful planning; and its is perhaps appropiate at this time to mention one or two principles which guided him. These principles were not necessarily formulated at the beginning of his career; rather they were the result of his long experience in philanthropic activity.

In the first place, he trusted the future. He did not think that benevolence and wisdom were confined to his generation. He was not under the illusion that what seems important to-day will necessarily be important to-morrow. He did not believe in tying up foundations to rigid and unchangeable purposes. He was familiar with English as well as with American experience in the creation of trust funds, and he would have agreed with Sir Arthur Hobhouse in the latter's comment on medieval foundations that "a nation cannot endure for long the spectacle of large masses of property settled to unalterable uses."

The wisdom of the last passage is illustrated in the futility of those charities which were after temple and monastery foundations, and no country suffers so much from the evil effects of these as India, which has a large amount of property, or is supporting bands of men who are not, to say the least, useful to society. In Europe, such foundations have been dissolved by State decrees or by some other drastic method. Witness the closing of monasteries in England by Henry VIII and Cardinal Wolsey. But who is going to do that in India?

The sole purpose of the Rockefeller Foundation is stated in its Charter to be

" to promote the welfare of mankind throughout the world."

If any restriction was laid, this was removed by Mr Rockefeller writing to the Trustees of the general Education Board in 1920.

" If in any gifts heretofore made to you by me there are any restrictions or limitations as to the specific purpose for which they are to be used, I hereby revoke such restrictions."

No Perpetual Endowment

The Endowments are not perpetual, because Rockefeller did not believe in perpetuity. " Perpetuity is a pretty long time," he used to say. All the Rockefeller Trusts are allowed to spend the income as well as the capital.

In fact, some of the trusts were liquidated, or amalgamated with general funds after it was found

that the motive for which these trusts were created no longer existed.

"Do not legislate for infinity."

This idea of Mr Rockefeller's has had great influence in shaping the policies of the boards which he established. The temptation to visualize the future in terms of the present —to think of the needs and methods of to-day as having a sure claim to immortality—is one which confronts trustees as well as founders of philanthropic foundations. For example, to establish under a permanent endowment in some university or research centre a department or chair of psychiatry or organic chemistry may seem, with such light as we have at the moment, a rational and socially desirable step. But what wisdom have we to-day to determine that a century or more hence psychiatry and organic chemistry will represent the pressing needs or the practicable techniques of that time? In endowing what they thought was of permanent importance, earlier generations made wrong guesses which embarrass us to-day. How can we assume that our guesses have any greater validity or are made with any clearer foresight?

This principle gave wide latitude to the Trustees of the Fund in the expenditure of the income as well as the capital. The general policy is laid down in the following notifications

(1) Ten years after the date of the gift, the income from it may be used in whole or in part for some purpose other than that for which the gift was made, such purpose to be as reasonably related to the original purpose as may be found practicable at the time, having regard to intervening changing conditions.

(2) Beginning five years after the date of the gift, 5 per cent of the principal of the fund may be used each year for any purpose for which income may then be used.

(3) After the expiration of twenty-five years, any part or the whole of the principal may be used for some other purpose, the new purpose—as in point one—to be as reasonably related to the original purpose as may be found practicable at the time, having regard to intervening changing conditions.

A full account is given of the total amount spent in 1937. This amounted to the huge total of nearly 10 million dollars, nearly three crores of rupees, besides recurring expenditures. The amount spent was distributed over 88 countries from Norway to Peru, the major part, of course going to the United States, and for medical and biological purposes. In fact, for some time past, it has been the policy of the Rockefeller Foundation to patronize medicine and biology to the exclusion of Chemical and Physical Sciences, so that the votaries of these latter subjects must find out some biological theme if they wish to get money from Rockefeller for their researches. We, for our part, do not consider that this is a sound policy.

Besides the U.S.A, the largest beneficiary has been China (nearly half a million dollars) where the Foundation gives grants to universities, medical colleges, for research and development. Rockefellers have a soft corner for China in their heart. In the review for 1936, the following sentence appeared:

"China to-day stands on the threshold of a renaissance. The Chinese National Government, together with many provincial and county authorities and private organisations, are attempting to make over a medieval society in terms of modern knowledge."

This proud ambition, in which the Foundation was participating, has been virtually destroyed by the events of the last six months. The programme was primarily a programme of rural reconstruction and public health. It was rooted in promising Chinese institutions like Nankai University and the National Agricultural Research Bureau, both in Nanking. It was promoting studies in subjects like animal husbandry and agriculture; it was carrying on broadly based field experimentations; and it was training men and women for administrative posts in rural and public health work.

Nankai University was completely destroyed last July. The universities and institutions in Nanking, where they are not too badly damaged, are serving to-day as army barracks. The field units in mass education and public health are so completely scattered that it is practically impossible to locate them. The work, the devotion, the resources, the strategic plans of Chinese leaders for a better China, have disappeared in an almost unprecedented cataclysm of violence.

At the moment there is nothing further to report. The Foundation still maintains its office in Shanghai. Whether

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there will be an opportunity to pick up the pieces of this broken programme at some later date, no one can foretell.

We express our genuine sympathy with China which as far as industry and science are concerned, is in very much same condition as India. We regret very much that the sincere attempts of the Chinese leaders at a Renaissance should be so rudely disturbed by the aggressive action of a neighbouring imperialist power. We can only hope that out of her present struggle will emerge a new and reborn China which will again carry forward the torch of a higher civilization. It may not be out of the way to mention here that medieval China gave to the world the three great discoveries which made modern Europe great. These discoveries are: paper and printing machine, magnetic compass, and gunpowder, but alas! China herself never made any largescale use of these. The Academy Sinica, and other Chinese Scientific Institutions, which were doing splendid scientific work now lie in ruins, as a result of the sanguinary conflict and still we call the modern age "An enlightened one!" Contrast with this the work of Kublai Khan, grandson of Chenghiz Khan, who conquered China in 1265, and instead of razing the monuments of previous times to the ground to celebrate his victory, raised China by his wise administration to a pitch of prosperity which it had not since witnessed (*vide* pages of Marco Polo). Who were the greater barbarian, the nomad Mongol, or the enlightened modern nations who carry forward civilization with howitzers, poison gas, and aeroplane's dropping bombs, and in times of peace with tariff barriers and discriminating legislations!

Rockefeller's Charities do not extend to India

Almost every European nation has been the recipient of Rockefeller Charities, even such ones as are piling up armaments for offence and defence, France for the University of Paris (The grateful French adorned J. D. Rockfeller Jun. with a Legion d'honnour), Germany for the Physics Department of the Kaiser Wilhelm Institute: England for her Medical Research Council, and Library of the University of Cambridge. Italy has been left out —the Abyssinian venture gave her too bad a name. We have grave doubts whether the Spirit of the Donor looks with approval upon such large endowments to countries which have surplus enough to manufacture armaments for the destruction of mankind. However, it is for the present administrators of the Foundation to satisfy their conscience. To us, The policy appears to illustrate, apart from anything else, the wellknown adage of "Carrying coal to New castle." The endowments will be justified if the recipients are men who are carrying on useful work, but probably, owing to their views, may not be in favour with their respective Governments.

In the long and impressive list of the endowments we are sorry to note that "*India occurs nowhere.*" We may be permitted to observe in this connection that neglect of India does not appear to be consistent with the motto of the foundation "*to promote the well-being of mankind throughout the world,*" when onefifth of the human race—inheritors of the most ancient civilization of the world—are left out altogether from the operation of the Great Charity especially when considerable scientific investigation is being carried on in this country under very discouraging circumstances. So far as India is concerned, the Rockefeller Foundation gave money for the construction of the All-India Institute of Hygiene at Calcutta, and have given a number of foreign scholarships to Indian graduates. But these grants are quite insignificant compared to those given to much smaller countries.

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Mount Kanobili Observatory

We have received two numbers of the *Bulletin* of the Abastumani Astrophysical observatory, Mount Kanobili, Georgia, U.S.S.R. of which E.K. Kharadse is the director. The observatory is situated in 41°.53′ North Latitude, 42° 45′ East Longitude from Greenwich, at a height of 1500^{m} above the sea level. It is a well known mountain resort in the Caucasus, well known for its climatotherapeutic properties. The mean temperature varies between − 5°C in January, to 17·5°C in July, the maximum rising to 31·5°C in July, and the minimum going down to −19°C in January. The cloudiness amounts to 51% in the year. The number of absolutely clear nights is 90, and partially clear nights 182. The transparency of the air is stated to be ·88 on the Pickering scale. These figures are the averages for 35 years. The site was chosen as the result of a scientific expedition sent by the Moscow Government in 1932. By the twentieth anniversary of the October Revolution (1937), the observatory became ready for work. It contains at present a 16-inch refractor, a 13 inch reflector, spectro helioscope, auxilliary mechanisms, and a power house. The instruments were all manufactured at the Leningrad Optical Institute. The observatory is maintained by the Government, and has five scientific workers, besides the director, and other staff.

Within the short period of its existence the observatory has turned out a large amount of astrophysical work, which is published in the two numbers of bulletins. The publication is in Georgian, Russian and English, and obstracts are sometimes given in English.

Though compared to the Great American observatories, the Mount Kanobili Observatory has started with modest equipments, we hope that it will develop into a great institution and will have many years of useful work before it.

Findings of the Bombay Advisory Committee on Education

The findings of the Committee appointed to advise the Government of Bombay on the question of vocational training for boys and girls in primary and secondary schools which made a survey of the present position of education in the Province can be summarized as follows:

"Over two-thirds of the population of the province live on agriculture. Our primary schools which are to cater mostly for the children in the rural area (*i.e.* for children of agriculturists and artisans who form the main bulk of the population) fail to appeal to an average villager. The reason is not far to seek. The village child is made to sit still for long periods at a time in the school room. The result of several years' schooling of this kind often is that the child grows into a weakling that is unable to stand the sun and the rain and is thus not of much use for hard work in the field. What little book-knowledge the child acquires does not appeal to a vast majority of the villagers, who, though generally illiterate, possess a strong common sense. Brought up on books and nothing but books, the village child looks down upon manual work. Conditions in urban areas are much the same."

What is needed is reorientation of educational ideals. Education must be made thoroughly practical, both in the primary as well as secondary stages, with a view to bringing our schools into intimate touch with the life, needs and traditions of the people.

This Committee was called upon to consider two important Reports on Education, whose authors give helpful suggestions as to how education could be made more realistic and practical. Messrs. Abbott and Wood have shown how it is possible to provide diverse courses

on definite practical lines at the secondary stage. This Committee have duly considered the proposals of these two specialists while making recommendations for diversified courses at the secondary stage. The Zakir Hussain Committee present a comprehensive scheme of primary education through suitable form of productive work.

After careful consideration, the Committee come to the conclusion that the principle of 'educating children through purposeful creative activities leading on to productive work' is sound; its adoption is best calculated to remedy the main weaknesses obtaining in the present system of education.

The Committee stress the fact that education to day suffers from an excessive amount of book-work. The child sits couped up in the class room from day to day and from year to year, conning his books and filling his notebooks, reading, writing, reciting, listening to the monotonous drone of the teacher's voice, and having his head crammed with as many scraps of knowledge as possible. Instruction within the class room is altogether divorced from the world without, and the child remains out of touch with the practical realities of life, the shadows of which he so assiduously or listlessly pursues in his books. The dull monotony of desk work seldom rouses the living interest or the intellectual curiosity of the child. Sedentary work, continued over a long period of time, has a disastrous effect on his physique, and passive absorption of knowledge, needing little active effort on his part, kills all originality and spontaneity and cripples him, mind and soul.

"To remedy this state of affairs, the Zakir Hussain Committee's recommendation is that some " Basic craft " be selected around which all school work could be centred. This would be possible to some extent with " crafts " that are really " basic," broad and fundamental, " rich in educational possibilities " and touching the life of the child and the community at all points.

" We are of opinion that among others the following should be chosen as basic crafts in the reorganized primary schools:—

Rural and Urban.

(1) Agriculture including subsidiary occupations- -Rural Area.
(2) Fruit and Vegetable Gardening.
(3) Spinning and Weaving.
(4) Wood-Work.
(5) Clay-Work.
(6) Home Craft.

" We are of opinion that at the primary stage not more than half the school-day should ordinarily be devoted to formal instruction in the class room."

The Committee make numerous other recommendations regarding primary and secondary education and allied matters. These may be briefly summarised as follows: —

The Cimmittee consider that Central Schools should essentially be schools of general education. They should be labelled neither vocational nor pre vocational.

The articles that are produced by School Children under the new Scheme of education should have as far as possible useable and/or marketable value.

In view of the fact that Hindusthani is fast becoming the national language of India, it is desirable that people in the non Hindusthani Provinces should have a working knowledge of every day spoken Hindusthani. Suitable provision should be made for the teaching of Hindusthani in the upper primary standards.

Special impetus should be given to the spread of education among girls and that in every scheme of compulsory education preference should be given to girls.

In view of the present schools being examination-ridden, external examinations should be abolished. Heads of Schools should hold their own examinations and make promotions after taking into account the record of the pupil's attendance, work in the class-room, farm and workshop and in general extra school activities, as also his performance in school examinations.

Provision should be made at suitable centres for continuation courses for the benefit of children who may leave school before completing the full primary course.

Early provision should be made for more training institutions and for an increase in the number of places in the existing women's training institutions with a view to securing more trained women teachers for lower classes of primary schools.

For the success of the scheme of Basic Education, it is essential that provision for a four years' normal

course (on a par with the Secondary School Course) for the training of teachers of basic schools should be made and that at least one such normal school should be maintained for each district.

Special training institutions for the training of teachers of Central Schools and Supervisors should be organised in all Educational Divisions and arrangements should be made in these institutions for vacation or refresher courses for teachers already in service and also for the systematic use of the Cinema, Radio, Museums, etc., as definite aids to work in schools.

Supervisors of Primary Schools should be specially trained for their work and that each such supervisor should ordinarily be in charge of about 50-60 schools with headquarters near about the centre of his beat.

Secondary Education

As regards the problem of Secondary Education the Committee suggest that the Secondary School Course should begin at the end of the seven years' course of Primary Education.

Managements of High Schools wishing to maintain Standards V to VII of the Primary Course should be encouraged to maintain classes for the full seven years' primary course.

The duration of the Secondary School Course should be four years, the Standards being numbered VIII, IX, X, XI in continuation of the Primary Standards I—VII.

It is proposed that the Secondary School Course should be divided into two groups:—(1) General; and (2) Science.

The four years' course should be divided into two stages: -(1) Standards VIII and IX; and (2) Standards X and XI.

For standards VIII and IX, the course should be common to all, with the exception of practical work.

Further a special committee should be constituted to draw up detailed syllabuses.

To start with, teachers of requisite qualifications for Vocational work should be selected so far as possible from among teachers who have worked or are working in Vocational Institutions of good standing and established reputation, in consultation with a Board of experts.

In Secondary Schools the mother-tongue should be the medium of instruction in all subjects except English and Hindusthani.

The Committee think that English should not ordinarily be introduced before the first year of the Secondary School Course, *i.e.*, before the commencement of the work of Standard VIII. If in any locality, there is an effective demand for the teaching of English in the higher primary stage and if thoroughly satisfactory arrangements by the appointment of a qualified teacher or teachers for instruction could be made, instruction in the language may be permitted as an optional subject from that stage without any financial obligations on Government.

The aim of teaching English should be essentially practical. Since the whole system of Secondary Education is examination-ridden, the Committee recommend that with a view to removing the tyranny of the Matriculation Examination, Heads of Secondary Schools should be permitted to hold their own examinations and issue Secondary School Leaving Certificates on the basis of full four years' record of pupils' work in the class-room, on the play-field, in the workshop, in the social and general activities of the school, as also his performance in the school examinations.

The University be moved to have the present Matriculation Examination replaced by special tests or examinations for entrance to Colleges affiliated to the University with a view to securing right type of students for University courses, none but those holding the requisite Secondary School Leaving Certificates being considered eligible for admission to the entrance tests of Colleges.

Till such time as the University decides to abolish the Matriculation Examination, it should be moved to take steps to improve the Matriculation Examination by providing alternative courses of studies and by modernising the Examination generally.

English-teaching Schools that are permitted to teach English from the initial stage (as the mother-tongue of the pupil is not one of the recognized languages of the Province) may continue to do so as at present provided that the schools arrange for regular instruction in one of the recognised languages of the Province and/or in Hindusthani.

The Department of Education should arrange for the periodical inspection of Vocational work in Secondary Schools in consultation with a Board of Experts.

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General

The Committee recommend that the curricula sanctioned by Government should be regarded as standard in which alterations or modifications not inconsistent with the principles and spirit of the sanctioned Course may be made to suit local or special conditions after intimation in writing to the Department of Education before the commencement of the school year.

An Advisory Board of Education composed of official experts in the different branches of education and non-officials eminent in educational, vocational, business, or social activities, should be constituted. Its function should be:—

(1) To advise Government on matters of educational policy and practice.

(2) To collect information about educational activities and experiments in other parts of India as also in foreign countries.

(3) To issue bulletins disseminating modern ideas in education.

(4) To suggest ways and means for securing the co-operation of State utility services as also of commercial and industrial firms, particularly in the matter of pre-vocational training.

(5) To suggest arrangements for vocational guidance to pupils in Secondary Schools.

The Advisory Board should appoint sub-committees for (1) general education and (2) pre-vocational training with powers to co-opt experts.

The Committee are convinced that for the success of the new scheme it is essential that a Special Publication Bureau should be constituted for the preparation of books and appliances for the use of teachers as also for village libraries, school children and literate adults.

The emoluments of teachers in primary and secondary schools should be in accordance with the standard scales of pay that may be laid down for other public servants of similar attainments and responsibilities.

The scale of grants to aided schools should be revised to enable them to employ qualified teachers on adequate scales of pay with reasonable fixity of tenure and provision for old age and also to enable them to meet the extra cost involved by the provision of practical work in primary and secondary schools.

The Committee stress the need of libraries specially meant for the benefit of children who cannot continue their school course beyond Standard IV and suggest that Government should publish pamphlets giving information about careers for pupils and also about the preliminary education needed for such careers.

Part-time classes for continuation or vocational education of those who cannot avail themselves of education in day or full-time schools should be organised as suggested in the Abbott-Wood Report, wherever there is a demand for them.

In view of the fact that this Committee has put forward a Scheme of Primary and Secondary Education with substantial practical instruction, it is essential to provide an adequate number of specialised vocational, industrial, trade and technical institutions. Government should take steps for the establishment of such institutions.

Transitional Arrangements

The Committee suggest measures for transitional arrangements and propose that a Special Officer not lower in rank than a Divisional Educational Inspector be appointed immediately to organise all work in connection with the initiation and development of the scheme of Basic Education, that he should act in consultation with a small Advisory Committee specially constituted for the purpose and that he be given the help of necessary assistants.

Compact areas providing necessary facilities be selected in each district to try the experiment of " Basic Education ". So far as possible, all schools in such areas should be transformed into schools of the new type, the full Primary Schools within the areas being organised as Central Schools, *i.e.*, schools teaching the full seven years' basic course with arrangements for instruction in two or more productive crafts.

The above experiment be tried in the first instance during 1938-39, that if the results are assuring enough to scope of the experiment be extended during 1939-40, that the position be reviewed fully before the end of 1939-40 and that in the light of experience gained, arrangements for the complete reorganisation of Primary Education be made within five years.

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The Committee are convinced that for the success of the Scheme of Basic Education it is essential that immediate arrangements for the special training of select trained teachers preferably with aptitude for productive or manual work of some kind should be made separately for each Educational Division. The emergency course of training at the start should be of about six months and the instruction should include among other things -

(1) Training in at least two basic crafts.

(2) Formulation and working of simple projects and schemes of correlated studies.

(3) Inculcation of idealogy of education through productive work, *viz.*, method of learning by doing, relating education to actual life, scope of initiative, sense of social responsibility, spirit of social service for national co-operative community.

(4) A Special Course in Physical Training, Drawing and Music.

(5) A short course in Physiology, Hygiene, Sanitation, Dietetics, Social studies and Hindusthani.

(6) Teaching of at least 25 lessons in the practising school under proper supervision.

These training schools should be residential institutions where the individual teachers under training have opportunities of receiving training to live a vigorous social life in an atmosphere of perfect co-operation.

Finally it is suggested that the supervisors for the experimental schools should be select men and women who should be specially trained to enable them to supervise and guide the work in the reorganised schools in their charge.

1851 Exhibition Scholarships

It is well known that India has been sadly neglected in her claims for the award of scholarships to her deserving sons. We have several times commented on this in these columns, and the matter has also received considerable attention from other sources. Recently the Registrar of the Lucknow University referred to it in a letter addressed to the Secretary to the Government of India, Department of Education, in which he asked him to represent to the Secretary of State for India, on behalf of the Indian Universities, "that the funds at the disposal of the Commissioners for the Exhibition of 1851, be in future allotted more equitably to India, in promoting the knowledge of science and art and their applications in productive industry, in extension of their accepted policy applied to other parts of the Empire.

The letter goes on to say—

"It is understood that after winding up the affairs of the Great Exhibition of 1851, the Commissioners were left with surplus funds from which a great educational centre has been built up at South Kensington. The Commissioners still possess an estate of the value of £500,000 and an available income of over £20,000 per annum.

"On an average they have awarded about 17 scholarships annually, each scholarship being of the value of £150/- p.a. The Universities of Great Britain, Canada, Australia, New Zealand and South Africa were invited to recommend candidates for these scholarships, but Indian Universities were left out of consideration.

"Since 1922 the Commissioners have awarded 5 senior studentships of the value of £150-500 each p.a. for which the British Universities and educational institutions are invited to make recommendations. There are 8 Dominion scholarships of the value of £280-300 p.a. for which the Universities in the Dominions are invited to make recommendations. Further, three scholarships are alloted to Australia, two to Canada, one to South Africa and one to the Irish Free State (since 1923). From all these privileges India was excluded.

"Will you be so good as to urge upon the Commissioners the desirability and necessity of fair treatment to Indian Universties, on the ground that the contribution of India towards the funds of the Exhibition was very substantial indeed, as the accounts of the Exhibition will disclose.The Commissioners in their 9th report in 1935 state that "it is probable that any additional funds placed at our disposal could more advantageously be applied in extending the scope of the overseas scheme to include the more recently developed countries of the empire, and in particular India, where the growth of University education, within recent years, has been most rapid." Even the Commissioners admit that India has been neglected. It is for us to press for equitable treatment being extended to capable research workers from India.

"His Majesty's Government have recently released the Commissioners from an obligation of £65,000 towards the cost of the Science Museum, the interest on

this sum alone amounts to £2,000 p.a. This amount will cover the cost of two scolarships of the value of £250-300 p.a., tenable for two to three years. Recently one such scholarship has been offered to India since 1937. This is entirely inadequate from the point of view of our contributions to the funds of the Exhibition, as also from the point of view of innumerable research workers, for whom additional facilities abroad will be greatly beneficial, and whose contribution to the national wealth of India is expected to be of great value.

The letter clearly states the facts leading to the establishment of the scholarships (also vide *Sc. & Cul.*, *1*, 480 82, 1936), and makes a strong case for the need of an equitable award of Exhibition scholarships to deserving Indians, and justice being done to this country.

Hydro-Electricity in Hyderabad States

Of the progressive Indian States though Hyderabad (Deccan) occupies a very high place, it has not paid attention to the possibilities of power development to to the extent as that of Mysore. Now the State has investigated its hydro electric possibilities and the extent of electric power that can be developed from the two rivers namely the Godavari and the Kistna, which flow through the state has been ascertained to be about 145,000 K.W. continuous and there are possibilities of generating another 70,000 K.W., from their tributaries. Three projects have been put forward but the one of immediate importance is the construction of a joint reservoir at Mallapuram across the Tungabhadra river which would be capable of developing 42,000 H.P. The power generated would serve a nitrogen fixation plant, metal industries and rural electrification.

A comprehensive scheme has been worked out in which hydro electric and irrigation projects are combined and the state would have a complete grid system. The total cost of all the projects for the development of the power possibilities would be about 65 crores and the capital expenditure would be spread over half a century and the scheme anticipates an estimated average return of about 8%.

Visit of Sir Leonard de Woolley to India

A press *communique* from Simla says that Sir Leonard de Woolley, the eminent British archaeologist has been invited by the Government of India to visit India in October and give the benefit of his experience in the work of archaeological excavations to the Government of India. The *Communique* says:

" Extensive excavations, carried out by the Archaeological Survey of India at Mohenjodaro, Harappa and other places, have revealed the existence in these regions of a widespread ancient civilization similar in many respects to the Sumerian civilization of the Near East with which it had established contacts. In order to provide for fruitful co operation in this particular field of exploration between the archaeologists in India and the archaeologists working in the Near East, it appeared desirable to the Government of India that the Archaeological Survey of India should have the benefit of the services of some eminent archaeologist who had worked on the Sumerian exploration in Iraq and other countries in the Near East. They have, accordingly, invited Sir Leonard Woolley to spend the next winter in India.

" Sir Leonard, who has accepted the invitation, will arrive in India by the end of October and stay in the country until the middle of January. During this period he will visit Mohenjodaro and Harappa, Chanhudaro and Amri, Taxila and Sarnath, Nalanda and Paharpur and other centres of archaeological activity in Northern and Southern India. This will enable the officers of the Archaeological Survey of India to exchange views with him as regards the technique of exploration. Advantage will also be taken of Sir Leonard's visit to utilize his vast experience of exploration for the purpose of suggesting sites which promise the best results from intensive exploration. In a country of the size and archaeological wealth of India, selective exploration is essential to derive the maximum benefit from the limited funds that are likely to be available for expenditure of this kind.

Sir L. de Woolley is best known as the excavator of Ur of the Chaldees, the city from which according to the Bible (Genesis) Abraham went away to the deserts westwards to escape from the cult of polytheism. Recently many of the stories recorded in the Bible are finding corroboration as a result of excavations carried out in the Near East, but probably no excavation of recent years has been more striking in its results than that of Ur by Woolley. This place is now a railway station on the Busrah-Baghdad railway, about four hours' railway journey from Busrah, and is marked

by a large mound. Excavations were carried out previously, and these showed that Ur was a flourishing Sumerian city from nearly 3000 B.C, to about 2000 B. C, and at times claimed hegemony over all the cities of Sumer. Though now about 100 miles from the sea-coast, it was, in the days of its prosperity, a seaport. Its decline was due to the rise of Babylon about 2000 B.C. as the ruling city of Mesopotamia.

Sir L. de Wooley's excavations which were carried out between 1923, and 1930, and are described in a popular way in *Ur of the Chaldees* has brought to light layers belonging to the times of the earliest Mesopotamian Kings Mes-anni-pa-da, as well as the funerary deposits in the tomb of Queen Shubad. But the most startling of his work seems to be that which is supposed to confirm the story of Noah's deluge. By sinking a vertical shaft, he came at a depth of 40 feet to a layer which was not virgin soil, but simply a bed of clay about 8 feet in thickness. Driving the shaft still further, he found remains of human habitation in the lower layers up to a great depth. It is supposed that the clay deposit was the result of a great river flood which overwhelmed the city, and laid it over with silt to a depth of 8 to 10ft. The next dwellers simply built over the old city-site.

Visitors to Ur are also pointed to a supposed residence of Abraham, who if he was a historical personage, might have been Wazir to a Sumerian King. There is also the impressive Ziggurat due to the Sumerian king Ur Nammee (2400 B.C.)

We hope that Sir L. de Woolley's visit to India will be fruitful, and we may invite the attention of the public to an editorial article in SCIENCE AND CULTURE of January 1936 about the ideals of archaeological research, and about the vast work lying before Indian archaeologists. It is also necessary that young Indian archaeologists should be sent abroad, and be allowed, by mutual understanding to participate in the excavation work done in Egypt, Syria, Palestine, Irak, Persia and Crete. This will widen their angle of vision, and enable them to learn the latest techniques of excavation, observation and preservation of antiquities.

Duration of the life of Fossil Man

It is usual to say that the longevity of man is constantly increasing with the betterment of the conditions of life, with abundance of nutrition, with the progress of hygiene, medicine and surgery. In France the mean duration of life was 38 years about 1835, but it now exceed 54 years. What was the condition in ancient and pre historic times?

M. Vallois has collected all the relevant data regarding fossil man which he has presented to the 10th International Congress of Pre-historic Science held at Oslo, and he is going to publish a fuller account in the Journal, '*L' Anthropology*'.

By examining the degree of attachment of the long bone to the skeleton or by noting the stage of eruption of the teeth it is possible to determine within a year or two the age of the infant or the adolescent; amongst adults the estimation is less precise because it depends upon the degree of the use of the teeth and above all upon the degree of attachment of the bone to the vault of the cranium. Both appear to be more premature amongst fossil men than amongst the modern.

M. Vallois has examined from diverse point of view 187 subjects of which 20 belong to the Neanderthal race, 102 to the upper-paleolithic, and 65 to the mesolithic age. For the neolithic age there were not sufficient data but there were 273 observations by Franz and Winkler and 141 by Spiegelberz and Pearson upon the Egyptians of Roman times.

All these facts have been collected and put together by M. Vallois within the following table.

	Age of death in years.				
	0—14	14—20	20—40	41—60	More than 60.
Neandarthal ..	40	15	40	5	0
Upper paleolithic ..	24.5	9.8	53.9	11.8	0
Mesolithic ..	30.8	6.2	58.5	3	1.5
Bronze age ..	7.9	17.2	39.9	28.6	7.3
Egyptian of Roman Times.	17	17	39.7	16.3	13.4
Austria 1829 ..	50.7	3.3	12.2	12.8	21
Austria 1927 ..	15.4	2.7	11.9	22.6	47.4
France 1896-1905 ..	25.3	2.6	11.5	17.3	43.3

The discrepancy relative to children appears to be due to the fact that they were often buried outside the burial ground.

In spite of that, the table shows clearly that the duration of human life has been increasing constantly.

Old men were unknown till mesolithic times begin to count from the age of Bronze, but it is really during the last century that their proportion became considerable.

M. Vallois concludes, contrary to what Metchnikoff thinks and what many of the biologists write, that it is probable that the premature mortality which we have verified amongst our ancestors is the one which corresponds to the normal state of man. The length of life observed in our day may be regarded as a secondary phenomenon due to the very new conditions of life created by civilization. Thanks to these conditions the modern man can live up to a period where the enfeeblement of his physical forces and the reduction of his activity will have rendered him incapable of living within a primitive society (*La Nature*, Feb. 15, 1938).

Crisis due to Overpopulation in Poland and its Economic Condition

Under the title; 'the drama of an overpopulated country,' M. Debeauplan tries to show the great effort made by Poland in course of the last 20 years for shooting up to the level of a great modern nation. The creation of the port of Gdynia (at present the first port of the Baltic Sea), the construction of 2,000 K.m. of rail road, 2,000 K.m. of roadway, show it abundantly. But Poland already with 34 millions of inhabitants is going to increase its population each year by 400,000. This population is 60% rural, and very dense for a territory having an area of 388600 K.m. square. If one admits that for 100 hectares (247 acres) of cultiviable land, there should be a maximum of 30 agricultural workers, we find that this figure reaches in Poland the value nearly 50 (exact figure is 48). The figures in other countries are as follows:-

France,	..	..	.. 23;
Belgium,	..	..	.. 33;
Holland,	..	..	.. 27;
Germany,	..	..	.. 30;
Italy,	..	..	.. 44;
Denmark,	..	..	.. 15;
(India,	..	..	52?).

Now considering the fact that there are 20 millions of peasants in Poland we find that if Polish peasants were to live up to the standards of other European countries, 10 milions of the these individuals should have some other occupation than agriculture. In Poland the salary of the agricultural workers varies from 35-120 francs per week (Rs. 2½ to Rs. 8). But this salary is only on paper; to find out the actual buying power this salary ought to be divided nearly by half. It is therefore not strange that a Polish citizen consumes 8 times more potato than a British citizen, but 5 times less sugar. We have very often remarked that the industry of a nation depends on the prosperity of its agriculture, therefore we are not surprised to find that there is an underproduction in the Polish factories, which is becoming more and more accentuated (In 1929 there were '84 million factory workers, in 1936 it has fallen down to '6 millions; the number of working hours has decreased from 1'6 billion hours to 1'12 billion hours. The number of unemployed has nearly quadrupled within the same period and the general index of salary has fallen from 100 to 53 in 1936. In order to improve these conditions certain notables in Poland advocate that the frontier should be extended at the expense of Czecoslovakia and Russia (frontier of 1772). This is a menace for the Ukraine, but such an idea find happily very few partisans. The Warsaw Government wants to organize emigration on the other side of the Atlantic and the project is before the League of Nations. But all the projects have so far been theoretical, practically one does not see how Poland where the misery among the labouring classes has been very intense can find out remedy for the consequences of overbirth. We have very often commented how overpopulation has caused (in course of historical times vast migration of people from the over-populated and relatively poor countries to the territories of other nations. If Poland suffers from a rate of increase in the number of inhabitants which is the highest in Europe, France suffers from the continued crisis of under birth, because, according to the census of 1938, the total population is only 42 millions of which 3 millions are foreigners settled in France.

---*La Science et la Vie*

Travancore Scheme for Conservation of Ancient Monuments

As a step in the systematic conservation of ancient monuments in Travancore, a survey by the State Archæological department of monuments having a historical, archæological or artistic interest in the State is now in progress. The result of this survey, so far available, show that among the most ancient of these

monuments are Hindu temples, some of which date as far back as the 8th century A.D. A passing phase of Pallava influence is evident from some of them, as is shown by the close resemblances of the cave temples at Kaviyur and Tirunandikara to Pallava work outside the State. Specimens of both early and later Chola architecture, as well as of the Vijayanagar period, are also to be found, while the Kerala style, which is more common, is distinguished by gabled roofs, wood carvings and absence of spires. Besides, specimen, of *vimanas, gopurams and mandapams*, characteristic of the early Chola, later Chola and Vijayanagar periods respectively are found in a good state of preservation, and a study of their architecture is engaging the attention of the Archaeological department.

The Government of Travancore have, in this connexion taken steps for the preservation of such of the ancient rest houses (*vazhiambalams*) as have an artistic architectural or historical importance, and have sanctioned an annual grant for the purpose. There are over 125 such rest houses, in the State, some of which have ornamented and sculptured pillars of great artistic excellence. A few of them date from the 10th century A.D., as is shown from the evidence of inscriptions.

Triennial Review of Irrigation in India

The *Triennial Review of Irrigation in India* for 1933-36 which has recently been released for publication is a helpful guide to know what the state of irrigation in India is at present, and what schemes relating to it have materialized.

With a steady increase in yield and acreage crops worth over Rs 100 crores were raised from areas receiving State irrigation alone during the year 1935-36. From about 10½ million acres in 1878 79, the area annually irrigated by State works alone has now risen to about 31 million acres —nearly ⅛th of the total cultivated area in British India.

The total capital outlay, direct or indirect, on irrigation and navigation works amounted, at the end of 1935-36, to over Rs 153 crores, the gross revenue for the year to about Rs 14 crores and the working expenses to about Rs 5 crores, thus yielding a net return on capital of about 5·7 per cent.

There are near about 300 irrigation schemes in operation in British India alone, of which 70 are of a major description. Of the 300, a third are classified as productive and the rest as unproductive, *i.e.*, as works constructed primarily with a view to the protection of tracts with precarious rainfall and to guard against the necessity for periodical expenditure on relief in times of famine. Of the provinces in India with extensive irrigation works, the Punjab is easily the first with an irrigated area of over 11 million acres. Madras comes second with nearly 7½ million acres, followed by Sind and the United Provinces with over 4 million acres each. The next is Bihar and Orissa with over 9,00,000 acres. In the percentage of area irrgated to the total area sown, Sind leads with a proportion as high as nearly 90 per cent. followed by Punjab with 35 per cent, Madras with 21 per cent and the North West Frontier Province with 20 per cent. Bengal is the only province where the area irrigated is less than 1 per cent of the total area sown.

The total average area irrigated in British India during the triennium was nearly 31 million acres, as against 30 million acres in the previous triennium, Sind and Bengal contributing largely to the increase due respectively to the functioning of the Lloyd Barrage cannals since 1932-33 and the extension of irrigation in the area commanded by the Damodar Canal. There has been an increase also in the United Provinces attributable mainly to the construction of the State tube-wells and the development of the sugar industry. The only decrease of any importance in the area irrigated was in the Central Provinces, where it was due to the character of the seasons and the economic situation. As in previous years, during 1935-36 also the Punjab showed the largest return on capital invested in productive works, namely, 14·2 per cent, followed by the North-West Frontier Province with 8·4 per cent, Madras with 7·4 per cent, Bihar and Orissa 6·7 per cent. Of the irrigation works of any importance completed during the triennium, by far the largest is the Llyod (Sukkur) Barrage and Canals construction scheme. With its 6,600 miles of channels and 48,000 miles of water-courses capable of drawing 46,000 cubic feet of water a second from the river, it is by far the largest canal system in India—possibly in the world. Its largest canal is the broadest ever excavated and exceeds the Panama Canal in width at bed level. The scheme commands a gross area of 7½ million acres—an area roughly equivalent to a quarter of England and more than the entire area irrigated in Japan. About 6¼ million acres, or as much as is actually irrigated in Egypt, are cultivable; and it is estimated that about 5½ million acres or an area

about the size of Wales, will actually be irrigated annually when the project has been fully developed. With the completion of the system of canals, its cost went over Rs 20 crores, and it is expected to yield a net return of 7·39 per cent ten years after completion, that is, in 1942-43.

The other great engineering work, completed during the period under review, is the Cauvery Mettur project. Framed with two objects in view, the first, to improve the existing fluctuating water supplies for the Cauvery delta area of over a million acres, and secondly to extend irrigation to a new area of over 300,000 acres, the project involved the construction of a large dam on the Cauvery at Mettur and of an irrigation canal (the Grand Anicut canal) taking off on the right bank of the Cauvery, and the improvement and extension of the existing Vadavar canal. Easily the first among those in the British Empire and believed to be the second or third dam in the world, the dam at Mettur is over a mile long and impounds a 60 square-mile lake with a shoreline of 180 miles and a maximum effective capacity of about 91,000 million cubic feet of water. Estimated to cost about Rs 662 lakhs for all works, including hundreds of miles of canals and distributaries, the project is expected to yield a net revenue of over Rs. 50 lakhs. Details are also given in the Review of the other important schemes, including irrigation projects navigation channels and embankment works, now under consideration in the different provinces. Of these mention may be made of the Haveli Project now under construction in the Punjab. Estimated to cost about Rs 535 lakhs, the project is expected to yield a net revenue of over Rs 43 lakhs, or a return of about 8 per cent on the expenditure involved. The primary object of its construction is to irrigate the land lying along the banks of the Chenab, below the junction of the Chenab and Jhelum, and to improve the water supply of the Sidhani Canal and of the Chenab inundation canals in the Multan and Muzaffargarh districts. The project consists of three distinct but inseparable parts, namely, the construction of a barrage below the junction of the Chenab and the Jhelum, the construction of a link between the Lower Bari Doab Canal near Montgomery and the Pakpattan perennial canal, and the provision of a winter water supply to the Burala branch extension of the Lower Chenab Canal. It is estimated that the project will provide a probable perennial irrigation for over 555,000 acres and a probable non-perennial irrigation for over 450,000 acres in the Haveli Canals tract and will, in addition, irrigate 128,000 acres on the Montgomery Pakpattan link and over 38,000 acres on the Burala Branch Extension.

In Madras a large project for impounding the waters of the Tungabhadra river has been under consideration for a long time. Technical and financial difficulties and the problem of reconciling rival claims to share in the waters of the river have stood so long in the way of the execution of the project. The general question of the allocation of the waters of the Tungabhadra is now under examination by the Governments concerned. Another large project under consideration is the Lower Bhawani project. Drill borings along the line of the proposed dam were completed, and experiments on the duty of water for dry crops irrigated by flow were conducted in certain areas under the project conditions. Observations were also made on transmission losses in certain channels. The Government of Madras have undertaken to spend a sum of Rs. 50 lakhs spread over three years on a widespread scheme of improvements to the minor irrgation works, as a measure of economic relief and to reduce rural unemployment in Madras, and good progress has generally been made. In Bengal, the work in connexion with the detailed survey and investigation of the Darakeswar Reservoir project, which is intended to irrigate 1,80,000 acres, was in progress during the period under review. Discharge observations have been made during the monsoon seasons to ascertain the supply available in the river. A contour survey of far-reaching importance in parts of Central and Western Bengal was commenced in February 1936, with a view to determining the possibilities of extending irrigation and improving the drainage and sanitary conditions of the tracts by large schemes, such as the More Reservoir scheme and the Darakeswar Reservoir scheme, and therby of developing that area.

In the Lower Kumar river, a navigation channel of considerable improtance, locks and sluices have been put in with the object of controlling silting in the river, at a cost of about Rs. 7½ lakhs. The locks and sluices can be so operated as to control the flow in the Lower Kumar river, but the silting troubles, though reduced, still continue and a final solution has yet to be found. Owing to financial stringency the dredging programme in the Lower Kumar river was of a restricted character. As a result the river was navigable to large steamers from May to November each year, and to shallow drafted steamers and boats during the remaining months.

NOTES AND NEWS

Another navigation channel of considerable importance, in Bengal is the Attrabanks river, which forms a cross country connexion between the Rupta and the Madhumati rivers. Unusually tortuous from its junction with the Bhairab river near Alaipur to the river Madhumati at Asthail, it is becoming badly shoaled. The depth of river is so reduced in winter that the shoals are not navigable without extensive dredging. During 1934-35 and 1935-36 the condition of certain shoals became so bad that steamer traffic through this river had to be closed and diverted along the Madhumati river and the Attya Halifax Cut Route. In this diversion route, too the Mangalpore and the Haridaspur shoals in the Madhumati river had to be dredged in the years 1934 and 1935. A policy of gradually abandoning certain protective embankments, which with experience have been found to be of harmful effect because of the obstruction caused to river spill, was continued in Bengal during the period. In the United Provinces, the proposals for the Nindeh reservoir for the extension of irrigation on the Garai canal system in the Mirzapur district are being reviewed with a view to utilizing the scheme for development of electric power. Investigations were also made during the period for extending urban electricity and irrigation by means of electrically driven tube wells, and canals fed by water pumped by electric power from rivers, into certain tracts of eastern Oudh not commanded by the Sarda Canal. Projects for three canals taking off from the Gogra, Kalyani and Gumati river were proposed.

As a preliminary step, a small scheme has been sanctioned for pumping 160 cusecs from the Gogra River and the erection of a power house at Sohawal Railway Station to supply energy for working the pumps and electrifying Fyzabad town. The canal is designed to irrigate over 43,000 acres annually. The expansion of similar power irrigation in Eastern Oudh will depend on the results of this experiment. An important work in progress in Baluchistan was the Quetta storm water drainage and embankment project at an estimated cost of Rs 2 lakhs. The project is designed to protect Quetta from the periodical damage caused by flood water. The existing drainage channels passing through the town are being improved so as to increase their discharging capacity and the vents of the bridges are being widened with a view to facilitating the passage of flood water through the town without causing any damage. The expenditure on the project up to the end of the year 1935-36 was about Rs 2 lakhs. The irrigation projects in Bombay now under consideration are the Kelegaon Tank project and the Waldevi Tank project. The first is intended to supplement the storage in the Ekruk tank at Sholapur, with a view to meeting fully the irrigation requirements of the tract under command and also the non-agricultural needs of Sholapur town with its cotton mills. The object of the Waldevi tank project is to provide Nasik town, Deolali Cantonment, the Great Indian Peninsula Railway and the Government Central Jail with an adequate supply of water. In the North-West Frontier Province, projects for lift irrigation of the area near Risalpur, and for the control of the Tank Zam and the Gumal River, are being considered.

Thyratrons for Grid-Controlled Rectifier Service

It is common knowledge that the output voltage of a rectifier fluctuates with changes in load current and supply line voltage. Frequently these fluctuations are so large that means must be used to correct them. This is particularly true when the rectifier feeds a load having a high back electromotive force and a small resistance, such as a storage battery. The facility with which the output voltage may be controlled by the use of thyratrons as the rectifying element has encouraged the design of tubes especially suited to this purpose. There is available a variety of circuits such that the output voltage of a rectifier may be made to obey any desired law. The successful application of these circuits depends upon the degree of reliability of the thyratron tubes used in them. To be most successful the tubes must possess certain characteristics. This paper (G. H. Rockwood, *Trans. the Electro-chemical Soc.*, 72, pp. 213-224, 1937) gives a brief review of the operation of grid-controlled rectifier circuits impose on the tube characteristics, and describes a particular type of thyratron with mercury-plus-argon filling which has proved especially useful in such rectifiers (Abstract from *Bell Sys. Tech. Jour.*)

SCIENCE IN INDUSTRY

Handloom Industry in Bihar

At the third conference of the textile section of the Department of Industries, Bihar, Rao Bahadur K. S. Rao, Textile Expert to the Bihar Government, in making a review of the work done so far for the development of cottage industries in Bihar, said that they had been neglected by the educated classes and left to the care of mostly illiterate and conservative artisans. The products of such industries were, therefore, comparatively more expensive than the corresponding machine-made articles. The designs and patterns handed down from ancient times and rigidly adhered to by the indigenous workers often failed to satisfy modern taste. Due to these causes the Bihar artisans were slowly losing their markets and were forced to give up their ancestral professions for more secure and remunerative occupation. The efforts of the Department of Industries in Bihar have been directed towards increasing the efficiency of the village artisans, the hand-weaver in particular, and towards improving the quality and style of their products. In spite of the best efforts of the demonstration staff of the Department in the way of equipping the weavers with labour-saving appliances and thereby improving their productive capacity, however, the results have so far not been quite satisfactory. For instance in the course of the last 18 years only 25 per cent of primitive looms or 40,000 out of the total number have been replaced with improved flyshuttle looms which increase the efficiency of the weavers by 50 to 100 per cent. By the introduction of the use of long warps with improved warping drums, the progress has been still less marked. But efforts in training the weavers to weave better class of fabrics have been more successful. The Bihar weaver was now able weave to and supply fabrics to satisfy modern taste. A great deal of work still remained to be done, continued Mr Rao, before the handloom industry in Bihar could be brought to a state of perfection. In addition to the improvement in the technique of weaving the organization of the manufacture and trade on rational lines was an urgent necessity. For this purpose an experiment was being conducted which was of importance not only to Bihar but to other provinces and States in India. The trade organization called the Bihar Cottage Industries was started in April 1936 with a grant from the Government of India embodying in it all the important economic principles of modern factory industries except in the details of actual manufacture. While centralizing the purchase and dyeing of raw materials and finishing and marketing of finished goods the various operations of weaving were being carried on by weavers of different villages in their own cottages. The weavers in this organization were having the freedom of working at their own time and were availing themselves of the services of their family members who would have been without work otherwise. The products of the weavers were standardized and were manufactured on mass product basis. The woven goods were collected in a central place and were made attractive by bleaching and finishing. In these processes only such machines were employed as were indispensable. This experiment of organizing the trade of cottage workers was being carried on for the last three years and the results achieved so far have been satisfactory. The Government of Bihar have proved that the Indian hand-weaver can manufacture even art textiles against standard specifications on mass production basis and market the goods successfully even in foreign countries. It was proposed to work this model organization till similar organizations were started by the educated classes for their own advantage and that of the artisans in the village. Besides rendering technical assistance to the adult artisans and maintaining a model trade organization for their benefit the Department also trained young men in various handicrafts with a view to producing not only a more efficient class of artisans but also to create a new class of leaders or organizers required for the development of the industries.

Mr. V. K. B. Pillai, who presided, in his address said that agricultural operations in India were seasonal,

entailing long periods of idleness among the rural population. This maladjustment could be remedied only by the provision of cottage industries as subsidiary occupations; and of the cottage industries hand weaving by its traditions and economic advantages stood pre eminent. A well planned development, he added, of the cottage industries would go a long way in introducing diversity of occupation so essential for the economic utilization of the surplus man power which is running into waste.

Economic and Industrial Conditions in Bombay

The Bombay Economic and Industrial Survey Committee have formulated a statement of the detailed heads of inquiry under which they are trying to collect information regarding the economic and industrial conditions of the Province of Bombay. Copies of this statement can be had from the office of the Committee by such members of the public as are in a position to supply information on the economic and industrial conditions and possibilities of the Bombay Presidency. The kind of information the Committee is anxious to have can be briefly summarized under three heads, *viz.*, (1) the existing industries of the province of Bombay, (2) possible new industries that could be started in the province, and (3) observations on the work done by the Government of Bombay in the realm of economic and industrial development so far, and suggestions about what could be done in the future.

Under the first head, the Committee is anxious to get information separately on rural and urban cottage industries. They are anxious to get historical notes on such rural and urban cottage industries as are in a state of decay, with special reference to the reasons for such decay; thus, for example, they would like to know whether the decay is due to changes in taste, or foreign competition, or internal competition from machine made substitutes, or whether it is due to faulty technique and marketing and financial difficulties. Such an analysis would be useful from the point of view of estimating the possibilities of the revival of these industries. With regard to the existing industries which may be under going difficulties, but which cannot be said to be in a state of decay, the Committee would like to get information on the topics of periodicity of employment, competition, markets, finance, organisation of the industry, and so on. Suggestions are also invited regarding measures, legislative, administrative or financial, which could be undertaken by the provincial Government, with a view to helping the existing industries of the province. Under the second head, suggestions are invited from the public particularly from traders and other engaged in, or coming into contact with, industrial pursuits, about possible new industries which could be started in the province having regard to the availability of raw materials and markets in the province. A large number of commodities of foreign manufacture are being consumed in the province to day, and there is no doubt that a number of these could be replaced by articles of domestic manufacture. It is very difficult to get into touch with all the persons who have made attempts to manufacture something or other, which could replace a foreign product. It is therefore requested that all persons who have experimented on new industries should get into touch with the Committee and place before it their views and suggestions regarding the possibilities of developing new industries. It is also requested that such persons should also indicate measures which they expect Government to undertake to help in the starting of these new industries. Under the third head, the Committee would welcome observations on the work done by the different departments of the Government of Bombay, such as, the Department of Industries, the Department of Agriculture, the Department of Co-operation, the Department of Forests, etc., in the matter of promoting the economic development of the province. Such observations may be made in a critical spirit, but it suggested that these should be based on either a study or a first-hand knowledge of the activities of the department concerned. Observations are also invited on what the Government can do in the matter of promoting the economic development of the province, and the Committee will gladly welcome any concrete proposals for economic development which may be placed before them by members of the public.

The foregoing remarks indicate in an adequate measure, the kind of work on which the Committee is engaged; and members of the public, who are in a position to help this Committee by supplying them with information on all or any of the items mentioned above, would be rendering the Committee and the Province a good service by doing so.

We may remark in conclusion that what is being done by the Bombay Government for the revival and development of the native industries should be followed in other provinces too, especially in Bengal where her indigenous industries are mostly in a decadent state.

SCIENCE IN INDUSTRY

Air-Conditioning in Indian Railway

Speaking at a meeting of the Calcutta Rotary Club on July 5, 1938 on the advantages of air conditioned travel on Indian railways, Mr L. P. Misra, Divisional Superintendent, East Indian Railway, Howrah, first stressed the fact that the amenities provided in first class carriages on Indian railways compared favourably with those on railways in any other country. Nevertheless, the fact remained that upperclass travel had not met with that response from the public in this country that it deserved. The climatic conditions, the extremes of temperature, the dust and the noise so inseparable from travel in tropical countries added to the discomforts of journeying and tended to keep passengers away. The railways in India had, therefore, to devise methods for overcoming these discomforts, and one means they had adopted was airconditioning. In America, which was the pioneer country in the adoption of air conditioning, several systems were in vogue. Conditions obtaining in India, however, made it impracticable to adopt a number of these systems. The system now generally in use in India was the electro mechanical system.

After explaining the technical aspect of air-conditioning, Mr Misra said that it had been discovered that if 25 per cent of the total volume of air that was passed through the coach was fresh, it would be ideal for the human body. The air that was supplied inside the coach, was first filtered, the moisture reduced and then it was passed through ducts. Under the electro mechanical system it would be easy to heat the carriages in winter. What would have to be done was to put out of action the cooling coils, and set up a contrivance for heating the air. Mr Misra said that on the B.B. & C.I. Railway air-conditioning was brought about by a system known as the ice-activated system. Ice was placed in the underframe, over which the air was made to pass. The air became cool in the process. Both systems—electro-mechanical and ice-activated—were on trial, and the Railway Board were not committed to either of them. But the electromagnetic system had this advantage, that it was more scientific, and by it, the temperature could be regulated with much more accuracy than was possible under the other system. Mr Misra said in conclusion that people who had travelled in air-conditioned coaches spoke highly of the advantages of the system, and in his opinion the prospects of the general introduction of air conditioned coaches on Indian railways were very bright.

We should in this connexion invite the attention of our readers to the following article on "Air-conditioning for Comfort" by Professor P. N. Ghosh. The article deals with in short the different aspects of air conditioning, and gives in some detail how the temperature of a room, house, etc., can be controlled according to our liking.

Air-Conditioning for Comfort

P. N. Ghosh

Ghose Professor of Applied Physics, Calcutta University.

There has been recently a move all over the world for controlling the weather inside dwelling houses. Though, to the ordinary mind, the idea may appear to be a high-priced luxury, yet, when one takes account of the realities, it forms an expectation that may within recent years be fulfilled for moderate dwellings. Human beings have developed the sense of comfort with the growing amenities of life supplied by mechanical developments of the last century, and one of the most noticeable is that of controlling the physical properties of the atmosphere so rarely found to our liking.

Within the last decade there has been very large progress in this direction, and it is now possible to maintain the air within an enclosure at a satisfactory standard of purity and with a combination of temperature and water-vapour content suited to the health requirement of persons exposed to it. It should be necessary to point out that the condition so created shall be automatically controlled without the need of human element for adjustment.

Beginning of Air-Conditioning

The term "Air-Conditioning" which is being more and more common nowadays was first coined in U. S. A. in 1907. In 1911, W. H. Carrier read a paper before

the Society of Mechanical Engineers on "Rational Psychrometric Formulae," their relation to the problems of meteorology and air conditioning and the basic principle enunciated in that paper forms the background on which the modern methods of "air-conditioning" are based.

Even in the States with its extremes of climate and with people always ready to give any new idea a trial, it was only for industrial application that the practice of air-conditioning found favour. This, however, had its advantage as the practical feasibility, the success and failure of the application were under the direct observation of trained men. Modifications were soon introduced, improvements made, and the commercial possibility of equipments from the basic knowledge of the natural laws affecting the design soon sufficiently advanced to get a successful start.

Contrary to usual practice, experiments were done in large installations treating a whole building to the equipment. Thus in Rio de Janerio in Brazil, the first public theatre was air-conditioned at a cost of £50,000 in 1911 through the efforts of German engineers. In the States large number of hotels and public places soon took up the idea, and comfort of air conditioning in big installations, where cost actually was of no consideration, became a reality. It has now spread all over the world in many public institutions and public undertakings.

Essentials of an Air-Conditioning Plant

The first essential of any air-conditioning plant is that it must be capable of controlling accurately the temperature, humidity, purity and circulation of air within a given enclosure irrespective of the state and variation of outside atmosphere, thereby regulating the effects of such air on materials and on people exposed to it.

The combination of temperature and relative humidity that ensures comfort has been found from a very large number of trials in America as well as in the Continent of Europe, and it has been found that in winter a temperature range of 60° to 70° F and in summer of 70° F and 75° F with 45 to 60% of relative humidity ensures the comfort condition. There is another point of importance namely the control of air movement, as the human body is particularly sensitive to draughts, and proper air-conditioning should ensure the absence of these draughts.

Starting from outside air one has to abstract heat and ensure adequate dilution of deleterious gases, smoke, odours, so that pure and fresh air may be admitted into the enclosure. It is well known that the total heat content of air in any given state is the sum of sensible and latent heats due to the presence of water vapour in the atmosphere and the regulation of the absolute moisture content of the air has to be secured with the help of a device which should be capable of very close automatic regulation. If the natural moisture content is greater than that necessary, the excess is precipitated with the help of finely atomized spray of chilled water which has to be constantly recirculated and passed through the evaporator or a mechanical refrigerating plant. In places where air heating is required in winter, there is the need also of a spray-chamber to add the desired humidity to the air in question. Successful air distribution calls for even diffusion without draught and the present tendency is to use high velocity outlets up to about 2,000 ft. per minute with an entering air temperature of 20° F below that of the conditioned space.

The field of refrigeration in air-conditioning is entirely different from those of ice-making and general low temperature work. The refrigerant shall be non-toxic thermo-dynamically efficient, compact and reliable.

The air-conditioning apparatus can be divided into three classes—

(*a*) Winter conditioners, with means of heating and humidifying;

(*b*) Summer conditioners, with means of cooling and dehumidifying;

(*c*) Year-round conditioners, which would have means to serve all the purposes.

Air-Conditioning in U. S. A.

It would be interesting in this connection to have a review of the conditions prevailing in the United States of America within the last few years.

"By the summer of 1936 the man who worked all day in an air-conditioned office, who travelled in air-conditioned trains, who lunched in air-conditioned restaurants, was beginning to demand at least summer cooling and dehumidification in his own home; and so to

guide him to his expected ideal, in 1937 the manufacturing and supplying sides of the electrical industry developed suitable units for year round air-conditioning as a standard equipment for new demonstration homes. In 1938 standardized unit conditioners ranging in size from 5 ton to 3/4 tons cooling capacity are coming into prominence as suitable units for residential blocks and cottages. The manufacturer foresees the time when air-conditioning small units are going to be as popular as gas and electric cooking ranges and home refrigerators. It is expected by the electrical concerns that in 1938 this factor would come up to 250,000 units.'

The Equipment

The most common type of equipment is the central fan plant to draw in and treat the fresh air required in the building at one point and then distribute the air by means of several ducts to the different portions of the building and a separate system to bring back the air for re treatment and re circulation. Instead of one central plant and number of ducts, sometimes number of unit conditioners are fixed as independent units. The conditioner comes from the factory already assembled, and on installation site requires only fresh air, electricity and water connections to work the cooling coils and the surface heaters and precipitators. For summer conditioners, as no heating arrangement is required, but refrigerating and dehumidifying form the essential components, the system in a sense becomes less complicated.

Air-washer and Dust Eliminators

The spray-type air washer of humidifier is actually a low pressure boiler adding water vapour to the air first passing through it, *e.g.*, with wet and dry bulb temperatures of 100°F and 65°F corresponding to a rather hot dry day, the air washer installation has to increase the water vapour content from 66·9 to 96·3 grains per lb. Tables have been constructed by which it is possible now to get a fair regulation of the humidity factor and cleaning factor of the air within the close approximation.

It is interesting to note that within the past few months a number of dust-extractors of the electrostatic filter type have been put on the market in small sizes for home, shop and office use; the dust-laden air is drawn round ionizing wires charged to 12,000 volts and then passed through a series of alternately spaced high potential and grounded plates. The dust particles after being negatively charged adhere to the positive plates which are charged to about 6,000 volts and have a thin coating of oil to assist adhesion of the dust particles.

The important factor in filters is not simply the removal of certain percentage of dust by weight but rather the effectiveness for removing certain objectionable constituents of the air which may be the finest particles present or the coarser ones within a certain range. For instance pollen grains and types of dust, producing asthma or hay fever generally fall to within 15 to 50 μ range and most filters now used in air-conditioning plants are capable of removing 98% in number of these particles.

It can easily be imagined that the atmosphere prevailing in enclosed spaces require considerable amount of water-spray to render the air free from impurities and an arrangement for dust-free air would require fairly large quantity of water for its proper conditioning. For large establishments evaporative condensers have been adopted in which the condensing coils are placed directly underneath the water-spray system and a pump lifts this condensed water for the purpose of make up. Outside air is drawn up through water covered coils, then through eliminator plates to remove excess moisture and finally forced up by a number of fans suitably placed on the top of the unit.

In mechanical cooling systems though ammonia was most generally used, within the last two or three years *Freon* is the most popular refrigerant. It is a dichloro-difluora-methane refrigerant. It is favoured for air-conditioning plants, because it is said to be non-toxic in concentrations up to 20% by volume for a period of 2 hrs.

Dehumidification

The most commonly used system for dehumidification is by cold surfaces, the temperature of the surface being kept low by refrigeration. Where cold water is available water circulation is resorted to. For quick evaporation and absorption silica-gel is used along with suction pumps and are found much more effective than the old calcium chlroide absorbers. Following the experience gained in oil and gas industries in America, lithium chloride and activated aluminium show great promise in this line. The general practice of drying up

the absorbents is that of electric heating which liberates the absorbed water fairly quickly and is coming more and more into prominence in America. Regarding the sizes of dehumidifiers one finds for the silica-gel units at present four sizes namely six hundred, fourteen hundred, two thousand seven hundred and five thousand cubic feet of air per minute.

Humidity control is now being closely maintained automatically; and the temperature is arranged on a sliding differential between the inside and outside conditions to avoid risks of shocks to persons coming into or going out from the conditioned spaces. A number of thermo-stats, hydro stats with their control valves are worked either by compressed air or by electrical relay units.

Air-Conditioning in England

In England there is no scope for any spectacular summer cooling and the majority of plants are arranged for year-round use. This year there had been an attempt to secure data regarding air-conditioned plants. A questionnaire was sent out in January 1938 to two hundred and thirty electric supply concerns of Great Britain up to the end of February 1938, 130 replies were received.

Ten authorities reported on twenty one industrial installations totalling 4746 H.P.

Five authorities reported on nine comfort installations in restaurants and cinemas totalling 1818 H.P.

Seventy two authorities reported on partial air conditioning systems in cinemas and public buildings, the installations consisting mainly of dust washers and heaters with plenum ventilation requiring motors, fans, and pumps totalling 2508 H.P., *i.e.*, with an average of 20 H.P. per installation.

It is estimated that the total load for air conditioning in Great Britain at the end of 1937 amounts to roughly about 70,000 H.P.

Installation and Maintenance Costs

Regarding the actual cost calculated on the basis of experience for the cinemas and public places one can broadly state that for a 2,000—seat cinema the annual cost for heating and plenum ventilation would be £4,500 and for complete air-conditioning £15,000 per year *i.e.*, an additional cost of £11,000 per year or a monthly expense of £900. The cinema people can well afford to bear this additional cost to attract sufficient number of visitors to pay for their own cost for comfort in the cinema.

Advantages and Uses of Air-Conditioning

In considering the desirability and the usefulness of air-conditioned residential quarter and office establishments it is well worth pointing out that more hours of ill health were caused by the common cold with its sneezing and coughing than by any other ailment. The first three days of cold are those when there is a great risk of infecting other people. Considerable amount of experimental work in America and in England and the continent had been conducted and as a result it has been found out that when persons suffering from a cold were shut up in a room with others in normal health, (*a*) if the room not air conditioned the cold infection spread to more than 60% of the people in sound health, (*b*) if the room air was conditioned the infection did not spread more than 5%. Many large and small air-conditioned offices in America kept records of time lost mainly through illness and the reduction in absentees is as high as 40% compared with the period before the equipment was installed. Moreover invigorating atmosphere led also to higher efficiencies in the office.

Of Benefit in Asthma and other Diseases

Patients suffering from asthma and hay fever being put into air conditioned rooms reported relief and this lasted (from hours up to days) after they left the rooms. If recovery had been made in an air-conditioned hospital ward it could be maintained provided the patient is kept in an air-conditioned bed-room. In the treatment of circulatory diseases constant and favourable degree of temperature and humidity beneficial to the patient could be maintained. As a result of recent experiment there is promising evidence that air-conditioning could be effectively applied to the cure of tuberculosis in its early stages even under trying weather conditions such as prevail in the tropics. It is expected that within three or four years experimental evidences would convince the medical profession the value of air-conditioning plants for their patients.

Other Uses

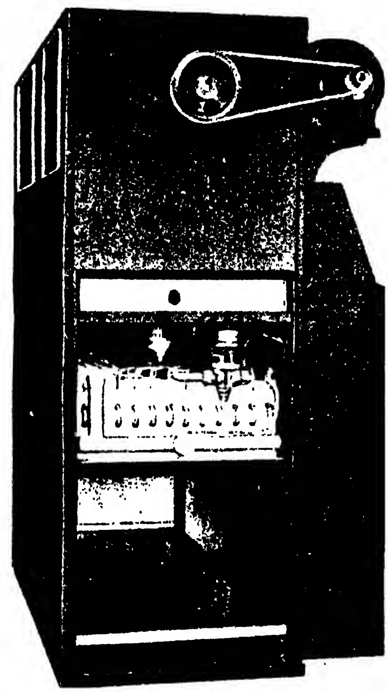
From experiences in America it has been found that for very small residential installations air-conditioning prevents wooden furnitures and fixtures in a house from over drying and resultant shrinkage and warping in dry

winters. In damp weather it prevents walls and windows from weeping, growth of mould is discouraged, carpets, curtains fabrics and specially library books keep much better due to free from dust and absorption of moisture.

Within the last five years the introduction of air-conditioning storages in America have shown less chance of wastage and a considerable saving in the value of food stuffs otherwise lost. The wider adoption of the idea is being retarded on the part of the customer due to (1) reluctance to pay more first cost (2) lack of confidence in estimated annual savings (3) lack of understanding of the proper tariff schedule by the electricity concerns. But these factors have now been investigated by the recent National Development Committee.

In 1937 a number of small sized household air conditioning units have been marketed in America and the inside view of the summer-self contained air-conditioner of Fair bank Morse & Co. of U. S. A. is given in the next column.

Within recent years attempts have been made in U. S. A. to have a small sized dwelling house to have its own air conditioned arrangement and units are now available for such dwelling houses at a cost ranging from 1,000 to 2,000 dollars and even there are smaller units for single rooms which are commercially available even at Calcutta within the limited price of Rs 1,200 to Rs 1,500/. There is indeed a great future for a comprehensive study of this problem for our country-men and it deserves the attention of the university authorities and other educational institutions to arrange



for proper training and research suitable to our local conditions.

MEDICINE AND PUBLIC HEALTH

The work of Tuberculosis Association of Bengal in 1937

The work of the Association is directed in many lines, chief amongst them are--Dispensary work, Publicity, raising of funds and training of medical men and Home Visitors.

A great stride has been made in the dispensary work. The total amount of diagnosed cases of pulmonary tuberculosis has been 3,757, a rise in number by 594 over the previous year. Besides, 173 cases of non-pulmonary tuberculosis were diagnosed. It is a great pity that 46·5% of all cases came to the clinic in very advanced and 33·5% in moderately advanced stages. About 30% of the diagnosed cases were unemployed persons and consequently neither could afford to pay the minimum cost of Rs. 3/- or 4/- for an X Ray nor could they have good food and well ventilated houses. The results of treatment, with all these handicaps, had proved to be very satisfactory. Of all the cases treated by collapse therapy 63% improved and 61% were rendered noninfectious. If the association could have more beds at its control, it is confident of showing still better results.

It is rather disconcerting to note from thee report that majority of these cases belong to the age group of 20-30 and the incidence of the disease is increasing amongst the menials. These two show that the disease is sapping the youth and is increasing in people who are the best media for propagation of infection.

The Home Visitor's work had been notable for the year. 33,765 Home Visits were made—a rise in number by 10,098 over the previous year. 4,378 contact cases were traced. Many home visits could not be done and contacts could not be traced as the Association is not yet solvent enough to engage more Home Visitors, though they need them very much.

There has been also a great increase in publicity work this year. 300 lectures were given in schools, colleges, exibitions etc. Besides, the Association had participated in 18 Exhibitions in Calcutta and 8 Exhibitions in Mofussil.

The Association is in urgent need of money. Though this year they have secured a grant of Rs 10,000 from the Government and other collections are greater than the previous year yet there is a deficit in the Budget. They have inaugurated a "Building Fund," a "Feeding Fund" (to supply extra food for the needy) and "Kalyani X-Ray Fund" (to help the X Ray Examination of those who cannot pay for it,) by collections specially made for these purposes. All these are very much needed and the Association needs more money for these funds to work them to a success.

The Association is the pioneer and the only organization in India which trains Home Visitors. It is turning out a number of them every year. It is also training Medical and Public Health Officers. Since 1935 four such courses were held by the Association.

The Association had done very well in introducing the "new" case cards which permitted of statistical analysis. This will standardise the work and case taking of all the dispensaries and will help a thorough analysis of the rich material the Association possesses. A few years hence, by the help of these "case cards" very important statistical findings could be worked out. We need them very much as without the help of such findings no well directed campaign against tuberculosis is possible.

The Third International Congress for Microbiology

The Third International Congress for Microbiology will be held at the Waldorf-Astoria Hotel, New York City, from the 2nd to 9th September, 1938, under the auspices of the International Association of Microbiologists.

The Congress will be composed of the following 9 sections:—

(1) General Biology: Variation and Taxonomy Convener: C. E. A. Winslow.

(2) General Biology: Microbiological Chemistry and Physiology. Convener: Stuart Mudd.

(3) Viruses and Viral Diseases. Convener: W. A. Sawyer.

(4) Rickettsiae and Ricksettsial Diseases. Convener: Hans Zinsser.

(5) Protozoology and Parasitology. Convener: H. W. Stunkard.

(6) Fungi and Fungous Diseasces. Convener: B. O. Dodge.

(7) Medical and Veterinary Bacteriology. Convener: F. P. Gay.

(8) Agricultural and Industrial Microbiology. Convener: S. A. Waksman.

(9) Immunology. Convener: M. Heidelberger.

The following are the names and addresses of the office-bearers:—

T. M. Rivers, M.D. President, Rockfeller Institute for Medical Research, York Avenue and 66th Street, New York City.

M. H. Dawson, M.D., General Secretary, College of Physicians and Surgeons, 620 West 168th Street, New York City.

Kenneth Goodner, Ph.D., General Treasurer, Rockefeller Institute for Medical Research, York Avenue and 66th Street, New York City.

The Registration fee is 5 dollars which will not include the cost of a banquet ticket or a copy of the *Proceedings* of the Congress.

A World's Fair will be held in New York City during the summer of 1939. Consequently, those who wish to attend the Congress for Microbiology should make plans promptly. The American Express Company, the official travel agency for the Congress, will be glad to assist in such plans.

Scientific workers who wish to register their names as delegates or as contributors of scientific papers are requested to communicate with Dr A. C. Ukil, Secretary, Indian Committee, International Society for Microbiology, All India Institute of Hygiene and Public Health, 110, Chittaranjan Avenue, Calcutta.

The effect of antithyrotropic serum on the action of human thyrotropic hormone

The thyrotropic hormone of the anterior lobe of the pituitary gland stimulates the thyroid gland Injection of this hormone leads to symptoms of hyperthyroidism. In Grave's disease it is suggested that this hormone is secreted in enormous quantity. Collip and Anderson (*Lancet*, April 16, 1938) have shown that if injection of thyrotropic hormone into an animal be continued for several weeks a state of resistance is gradually developed and the thyroid gland is no longer influenced by the hormone. If serum from such an animal be injected to a normal animal the latter acquires a passive immunity to the thyrotropic hormone. The serum of the resistant animal possesses strongly antithyrotropic properties. This antithyrotropic serum is species-specific. Antithyrotropic serum derived from ox pituitaries is found to have no therapeutic value in the human subject. It is very difficult to collect human pituitaries for the preparation of antithyrotropic serum.

—*S. Banerjee.*

Hyper-adrenalism and Buerger's Disease

In Buerger's disease there is hyperplasia and degeneration of the middle coat of small arteries together with much proliferation and desquamation of the innercoat. Similar changes are also seen in veins but they are not occluded. It is suggested by Oppel (*Arch. Ital. clin.*, 1937, *47*, 5, 481,) that hyperadrenalism is a possible cause of Buerger's disease as better results are obtained by the excision of suprarenal of one side. Similar changes in the vessels are obtained by transplants of suprarenal tissue in males but less easily in females. Castration in males has no effect but if it is followed by implantations of ovary the arterial changes following the suprarenal grafting are insignificant or absent. This indicates the value of ovarian extracts in the treatment of Buerger's disease.

—*S. Banerjee.*

Vitamin B_1 and Nicotinic Acid in Pellagra

Spies and Aring (*Jour. Amer Med. Ass.*, 1938, April 2, p. 1081) have treated cases of classic pellagra with peripheral neuritis by the administration of vitamin B_1. The neuritic pain is promptly relieved by the intravenous injection of vitamin B_1. Glossitis and stomatitics are however not cured by vitamin B_1. Nicotinic acid cures these conditions. Pellagra is

therefore the result of more than one factor, a conclusion also arrived at by Guha in 1931 (*Brit. Med. Jour.*, 1931, (ii), 53).

— *S. Banerjee.*

Vitamin B_1 in Herpetic Keratitis

According to J. Nitsulescu and E. Triandaf (*Brit. J. Ophthal*, Dec. 1937, 654.) Vitamin B_1 was found to be very useful in two cases of herpetic keratitis. The pain is relieved, progress arrested and cure hastened. There is however no evidence of aritaminosis.

—*S. Banerjee.*

Vitamin C and Blood Sugar Level

G. Izar and G. Cairrone have shown (*Med. Jour.* 8, 1938, p. 5) that subcutaneous injections and per oral administration of vitamin C are found to cause a fall e blood sugar level in normal as well as in diabetic subjects. The fall reaches its maximum about an hour after the injection and is followed by a progressive rise up to the original level in the next three hours.

–*S. Banerjee.*

Public Telephone

Independent bacteriologists and employees of Post Office, Medical Departments in England and United States have examined all public telephones. They say that the risk of tuberculosis infection from the use of the telephone is negligible.

Our Medical Article for August

The following article on 'Tuberculosis and Industry' has been contributed by Dr. P. K. Sen of the Department of Tuberculosis Research All India Institute of Hygiene and Public Health, Calcutta for our 'Medicine and Public Health Section' of the present issue of the journal.

Industry and Tuberculosis

P. K. Sen

Department of Tuberculosis Research, All India Institute of Hygiene and Public Health, Calcutta,

Tuberculosis has been present among human beings for a very long time. But never before has the disease been so active and wide spread as in this industrial age. We all know tuberculosis spreads by contact, specially from one person to another. Any factor which increases the chances of contact also increases the possibility of more people being affected by this disease. Industry is one of the most potent factors in this direction.

Formerly, people used to be of more rural habits. They lived in villages, there was no congestion; the houses being wide apart, they came in contact with fewer persons. They, in short, lived in a manner which afforded a much better protection from infection from others. With the advent of industrialisation, people from different parts of the country were drawn to areas where factories were located, so that soon there was over-crowding. Besides, being aggregated in small areas, they came to more intimate contact with one another both in the workshops and private lives. The housing problems of the workers, though becoming increasingly important as days passed, were neglected at the begining. There was no plan for ventilation, no plan to avoid overcrowding. The workers gathered as close as was possible to their working areas. This made the housing and living conditions of the workers extremely poor and insanitary. We are conducting an investigation amongst the workers of a jutemill near Calcutta. The crowding, living conditions and sanitation of the houses where workers live are very unsatisfactory. Most of the workers come for work from the villages. Though poor in their homes the conditions of living are quite different. They are just the people who do not acquire much specific resistance against tuberculosis as the incidence of the disease is much less in rural areas. They are, in the words of Prof. Cummins, " Virgin Soil ".

In the cities where the chances of contact are greater, people are generally infected at a young age. If the infection is not overwhelming, which in most cases is the case, the disease is not established but the person acquires a specific resistance which can cope with, to a large extent, the subsequent infections to produce disease. These village people are generally not infected, that is, they are like "Virgin Soil". When they come for work in the industrial areas, they fall into this deep mine of insanitary conditions. The insecurity of position, unhealthy social habits, and mental disturbances arising out of this new environment sap out their vitality. Added to these is the greater chance of infection due to over crowding both at the working places and in houses. A person who was not infected before, if infected with massive dose of bacilli, facilitated by the above conditions, he gets the disease quickly and in a more fulminating form. They die like flies and infect others rapidly and surely because of their ignorance and peculiar living conditions. Borrel, the great French pathologist, first detected this peculiar behaviour of the disease in such uninfected men. The African recruits in the Great War, the Senegalese, came to France. They were farthest away from civilization and tuberculosis amongst them in their native country was rare. They were, therefore, "Virgin Soil". When they arrived in France, they fell into an atmosphere where moderately heavy infection was possible. The French men are used to this and they do not get the disease. But the Senegalese, as they had no previous infection and consequently acquired resistance. Fell a prey to the disease and they died like flies. Though India and her village people are not in the same category of "Virgin Soil" as the Senegalese, yet certainly they are not as resistant as the Europeans or the town dwellers of India. So, when they come for search of work and have to live in the crowded environment where opportunities of massive infection are more frequently present, it is very likely that many of them get the disease and behave somewhat like the Senegalese.

India is on the road to industrialization. If at this very beginning we take note of the havoc that has been played by tuberculosis in other countries we can minimize much of the sufferings and can save many lives. We must try to improve the housing conditions, give protection by various methods to those who are not infected and remove the diseased persons from amongst the crowds. We do not need the building of expensive houses for workmen. We cannot afford it in this present financial conditions of our country. With the advance of industries we hope to be richer. Then only can we undertake to build houses for workmen as is being done now in Germany and at places in Great Britain. What we want now is good planning for even the *Bustee* or *Kutcha* houses. Much could be achieved by simple planning to minimize crowding and to increase ventilation. To my mind, this should be one of the greatest obligations on the part of the authorities to look after the living conditions of the labourers. This should be done with the inception of the industry in a certain area. Planning from the beginning is important as it is very hard to demolish already built areas and to rebuild them. Besides, once the workers are used to insanitary living, it is very hard to change the ways even if they are housed under better sanitary conditions, later on. But, if they are educated and disciplined in the ways of the living from the very entry in the industrial life they have a much better chance to acquire healthy habits and to live accordingly.

The dangers mentioned above are the general effects of industrialization in a population who are not used to it. But there are some special industries which make the workers particularly susceptible to tuberculosis. All the industries evolving silica dust in their process are dangerous. The chief amongst them are pottery, sandstone, granite, metal grinding, sandblasting, manufacture of scouring powders, gold mining and coal mining. In all the above industries, silica dust is given up in very minute particles. They are inhaled by the workers during the whole period of their work. The inhalation of this dust may cause a disease of the lungs which is known as silicosis or miner's phthisis.

The production of silicosis depends on the nature of dust its chemical composition, concentration in the working atmosphere and size of the particles and also on the presence of any previous lung-disease of the worker.

Quite an amount of work has been done on the chemical composition of silicious dust to find out the most potent composition in the causation of silicosis. From the result of all the investigations it seems that "free silica" is the most dangerous form of dust to cause silicosis. Silicates are less dangerous though at one time sericite or silicate of aluminium and potassium (K_2SAlO_3 6 SIO_2 $2H_2O$) was thought to be more dangerous than any other form.

Silica dusts are inhaled in the deeper parts of respiratory tract. They are then engulfed by certain

cells coming into the terminal portions of air-passages and carried to the nearest lymphatic. There they lodge and get dissolved in tissue fluid. Silica is an extremely insoluble mineral but investigations of King and Mellor show that it gets dissolved in tissue fluid very slowly. As silica is a tissue poison it causes necrosis of the area where it gets dissolved and there is a surrounding re-action of fibrosis. It is why in silicosis the lungs become beset with nodules of fibrosis. The last International Silicosis Conference came to the conclusion that silicosis is due to "solution" of the silica in tissue fluid. If that is so, it probably is right to say that the form of silica, combined or free, which is most soluble in the tissue fluid is the most dangerous form of dust.

In order to produce silicosis the dust must be present in the atmosphere at a certain concentration. If the dust is diluted with air or by any other medium to a certain extent body can dispose of the dusts and no harmful effect occurs. Cummings thinks that a normal man may work in an atmosphere unimpaired in health if the silica dust does not exceed 5,000,000 particles per cubic foot of air. This is almost the threshold" number of silica dust to produce disease. Any concentration above this forbodes danger and the more the concentration the more is the likelihood to develop the disease and to develop it rapidly.

The size of the particles also plays a great role in the production of the disease. The smaller the particle is, the longer will it float in the air, the easier will it enter into the deeper parts of respiratory tract and the sooner will it get dissolved, as smaller particles expose a greater total surface area of the dust to the action of the plasma. It is generally believed that particles of 5 micron and under in diameter are dangerous. This is known as "Effective size range." Any particle above this range is probably not dangerous enough to be taken into account. In fact most of the particles from the diameter of 10 micron and above cannot even enter the deeper parts of the respiratory tract. They are caught by the cilia of the mucous membrane of the upper air passages and are thrown out. Thus they have no effect.

Once a worker gets silicosis he is almost certain to die of tuberculosis in later years. No definite reason could be given for this susceptibility of the silicotic to tuberculosis. But it has been found to be true. Many authors believe that tuberculosis and silicosis are inseperable conditions, that is, when silicosis is present there is every likelihood of tuberculosis being present too. In my own investigation among the South Wales silicotic-coal-miners, no element of tuberculosis in some of them could be detected even by the most laborious search by clinical and *postmortem* examinations. We may, therefore, believe that though silicosis makes the person very susceptible to tuberculosis, tuberculosis is not universally present amongst the silicotics. But this cannot mitigate the dangers to which workers in all silica industries are exposed.

It will be realized from the names of the industries mentioned that many hundred thousands of workers are working in an atmosphere laden with silica dust. In Europe, America and South Africa a great amount of work has been done on preventive measures. The factories or the mines must be well ventilated, water sprays are used to bring down the dust particles and masks are used. There are many devices for all these preventive measures which are suitable to particular conditions. By these measures they have brought down the number of silicotics. This is a gain not only for the workers but for the capitalists also. For each case of silicosis, by the Compensation Act, the authorities have to pay quite a large sum of money as compensation.

It is unfortunate that almost no work has been done on the 'dusty industries' in India. We have many industries where silica dust is given out in clouds and it is likely that many of the workers are falling a prey to this disease and later to tuberculosis. It is urgent that we should conduct investigations amongst these industries and find out the incidence-rate of this disease and of tuberculosis. If required all the preventive measures must be adopted. The sooner it is done, the better.

The Tuberculosis Enquiry under the Indian Research Fund Association has begun an investigation amongst the Jute workers in a Jute mill in the neighbourhood of Calcutta. Most of the labourers there are recruited from villages. We shall be able to see the effect of this industrialization on the rural people. Besides, jute is a dusty industry and we may be able to find out whether or not there is any dust hazard in this important industry which is a monopoly of Bengal.

Research Notes

New Types of Vitamin-D (D_3 & D_4)

That ergosterol is not the only pro-vitamin D, has definitely been established in recent years (Windaus, Lettre and Schenck. Ann, *520*, 28, 1935; Windaus, Schenck and Werder, *Z. Physiol. Chem.* *241*, 100, 1936). It has been found that irradiation of 7-dehydro cholesterol prepared from cholesteryl acetate, gives rise to a substance of high antirachitic activity (24,000 international units per mg. as compared with 40,000 units for vitamin D_2 which is obtained from ergosterol). This variety has been known as vitamin D_3.

A very recent observation by Windaus and Trautmann (*Z. Physiol. Chem.*, *247*, 185, 1937) has given further proof of the above view. It has been shown that irradiation of 22 dihydro erogosterol yields a substance (m.p. 107 8°, $(\alpha)D^{18}$ -89·3) having a high anti-ricket potency and showing an absorption maximum at 265 m μ as shown by vitamin D_2 and D_3. This new variety of ricket-preventing substance has been termed as vitamin D_4.

This development in the line of chemistry of sterols and vitamin D, that sterols irrespective of the molecular weight can be made to possess antirachitic property, will add much towards the progress of science as well as towards the alleviation of human sufferings.

—*M. C. Nath.*

Influence of Heavy Water upon Amylase Formation

Germination of many seeds is associated with marked increase in their amylase activity. This increase is often due to the formation of several starch-splitting enzymes. Malted barley has been found to contain at least two distant amylases in proportions which depend upon the treatment of the grain. As water is an important factor in these changes and is also essential to the action of the amylases after they are formed, it is of special interest, therefore, to study the influence of heavy as compared with ordinary water upon the generation of amylase activity during the sprouting of barely.

Caldwell and Doebbeling (*J. Biol. Chem*, *123*, 479, 1938) have performed experiments to compare the amylase activities of barely grains before germination with those of grains which had been allowed to germinate in water and in different concentrations of heavy water. The comparisons were made at definite intervals during the course of germination and also at what appeared to be the same stages of germination of the grains. The concentrations of heavy water studied were 1, 10, 50, 100%.

The authors conclude that heavy water is not appreciably unfavourable to the metabolism of this grain even when present in concentrations many times higher than those which are probably normally encountered in nature.

Hundred per cent heavy water, however, had a markedly unfavourable influence upon the rate and extent of the sprouting of the barley and upon the generation of the amylase activities which is affected in the same direction as the germination of the grain. Moreover, the unfavourable in-influence of the higher concentrations of heavy water was much more pronounced with the starch splitting (a-amylase) than with the sugar forming (B-amylase) activity.

—*H. N. B.*

UNIVERSITY AND ACADEMY NEWS

Royal Asiatic Society of Bengal

An Ordinary Monthly Meeting of the Royal Asiatic Society of Bengal was held on Monday the 4th July, 1938, at 5-30 p.m.

The following candidates were balloted for as Ordinary Members:

(1) Andrew McLaren Carstairs, M.A., Bengal Chamber of Commerce, Calcutta.

(2) Suprabhat Mozumdar, M.A. (Cal.), Master, Rajkumar College, Raipur, C.P.

The following papers were read:—

(1) Chintaharan Chakravarty. Kāśīnātha Bhaṭṭa and his works.

A fairly large number of small treatises, principally on Purana or Tantra topics, ascribed to one Kaśīnatha Bhaṭṭa Bhada of Benares, *alias* Śivānandanātha, are available in manuscripts in different parts of India. But very few of these works have been brought to the notice of scholars either through descriptive notes or through print. Little again is known about the author. So an attempt has been made to collect an account of these works as well as of the author so far as could be gathered from a survey of them, mainly on the basis of the manuscripts of a large number of Kāśīnātha's little known works, belonging to the Royal Asiatic Society of Bengal.

(2) R. Grace Lewison. Folk-Lore of the Assamese.

A collection of 39 Folk stories, in English translation, collected during the author's ten years' residence in Assam. Narrator's name given in each case. The stories are classified as historical, moral and amusing.

The following exhibits were shown and commented upon:—

(1) M. Mahfuz-ul Haq.—A note on a Persian Manuscript of Sahā'if i-Shara'if of Muhammad ' Askari-al-Husainī ' of Bilgrām.

The manuscript, which comprises the biographical sketches of the Persian prose writers of India and Irān, has recently been acquired by the Royal Asiatic Society of Bengal.

The manuscript is apparently unique as no other copy is known to exist in any well known library. A feature of the manuscript is that it is the author's autograph copy.

The author, Saiyyid Muhammad ' Askari bin Saiyyid Khurshīd ' Ali, was born at Bilgram. He was a talented Persian scholar and poet of his age. He composed the Sahā'if in 1213 A.H. (1815-16 A.D.). It contains valuable data regarding the Persian prose-writers in general and the contemporary Indian writers in particular. There are several interesting specimens of the compositions of the Mughal kings, princes and princesses.

(2) Chintaharan Chakravarty.—Manuscript of a hitherto-unknown work of the *Pārānanda* School.

The only work so far known expounding the doctrines and practices of the little-known but cosmopolitan Parananda School of Tantric worship, which puts a taboo on ritualistic details as also on animal sacrifice, which apparently is an essential fea of Sakti-worship, appears to be the *Pārānanda Sūtra*, published in the Gaekwad's Oriental Series (Volume

LVI, Baroda, 1931). The Royal Asiatic Society of Bengal possesses a fragmentary manuscript of a small work, called the *Pārāmānandamatasamgraha*. It gives a brief account of the school. While the printed text, which is diffuse, is at times obscure, the present work, though of small extent, is clear and systematic.

(3) Baini Prashad. Habitat group of the goggle-eyed fish or mud-skipper *Periophthalmodon schlosseri* (Pallas).

Gobies of the genera *Periophthalmodon* and Periopthalmus represent, in their habits, two of the most terrestrial types among fishes. They frequent the sea shores and estuarine mud-flats of the Indo Pacific Region, and are sometimes found considerably above the water level, on aerial roots of plants and other objects that may be present in their habitat.

The mud-skippers breathe atmospheric air direct, and their skin is especially modified for conserving moisture. Their eyes are well adapted for a sharp aerial vision, and they use their highly muscular pectoral fins for locomotion on land. They feed on small animals that are left stranded on the mud flats by the receding tides.

The exhibit shows a portion of the foreshore of Matlah at Port Canning. The dwarf Sundari shrubs (Avicennia officinals L.) with their aerial roots form a characteristic feature of the habitat. The other noteworthy inhabitants of the mud-flats or of the associated saline pools are the Crabs, *Varuna litterata* (Fabricius and *Gelasimus annulipes* Latreille and *molluscs* of the family Cerithiidæ.

National Institute of Sciences of India

An Ordinary General Meeting of the National Institute of Sciences of India was held in the Library Hall of the India Meteorological Department, Poona, on the 25th and 26th July 1938 from 9 a.m. to 11 a.m. and 3 p.m. to 5 p.m. on both the days.

A Symposium on "Weather Prediction" was held, in which the (Abstracts of papers to be read enclosed herein) programme was as follows:

Dr C. W. B. Normand.—Opening remarks.

Long Range Forecast—

Dr S. R. Savur.—Seasonal forecasting in India.

Medium Range Forecasts—

Mr S. Basu.—Franz Baur's forecasts for 10 day periods.

Daily Forecasts—

(1) Air mass analysis and short period weather forecasts

Dr S. N. Sen. Air mass analysis and short period weather forecasts.

Dr S. K. Pramanik. Application of air mass analysis to the problem of forecasting of nor' westers in Bengal.

(2) Upper Air Data and Weather Forecasts

Dr K. R. Ramanathan. Upper air data and weather forecasts.

Dr N. K. Sur.—Latent instability in the atmosphere and its consequences.

Mr S. P. Venkiteswaran. Rainfall due to winter disturbances and the associated upper air temperatures over Agra.

Dr S. K. Pramanik.—Upper air data and weather forecasts.

(3) Forecasting for aviators

Mr P. R. Krishna Rao.—Weather forecasting for aviation with special reference to local forecasts.

(4) Kinematical Methods in Weather Forecasting—

Dr S. K. Banerji.—Kinematical methods in weather forecasting.

Book Review

The Metallurgist's Manual, (*Cheap Edition with supplement*) *by T. G. Bamford, M.Sc., and H. Harris, M.Sc., published by Chapman and Hall, Ltd., London, Price 7s-6d.*

This book is intended for the use of metallurigists, metallurgical students at universitiies and technical schools of engineers and of others interested in metals. In accordance with the object, emphasis has been laid more on the practical aspect of the subject than on the theoretical background. In fact the book is one of the few publications on the essentials of metallurgy. The book is divided into seven chapters; each chapter gives a fairly clear account of the subject included in it. Chapter I deals with sampling and assaying of ores of copper, iron, manganese, gold, silver, platinum and other important metals - their qualitative and quantitative examinations. Chapetr II provides sound methods for the complete analysis of both ferrous and non--ferrous alloys of every day use. Chapter III is devoted entirely to the complete examination of fuels and refractories. Chapter IV shows in a very precise way how to calculate furnace charges—an information which is of fundamental importance to the beginners and workers in the metallurgy. Chapter V gives a clear and complete account of the methods available for the measurement of high temperature and the procedures actually adopted., Chapter VI deals with the practical sides of metallography and industrial alloys, which are very well treated. Chapter VII contains a summary of the manufacture of nonferrous castings.

The tables appended at the end of the book serve a variety of purposes and are seldom found together in any single text book on metallurgy.

The book can be recommended to metallurgists, students of metallurgy and to others interested in metals.

H. N. D. G.

Television—Theory and Practice--*by J. H. Reyner, B.Sc., A.C.G.I., A.M.I.E.E., Second and Revised Edition.* Chapman and Hall Ltd., London 1937.

We welcome this new edition of the well known publication by Mr Reyner. The old edition has undergone extensive changes and a large portion of the new edition has practically been re-written. The book is divided into two parts, the first dealing with the receiving technique and the second with the transmitting technique. As stated by the author more stress has been laid on the fundamental principles of the subject—and these have been very lucidly explained—than on the detailed descriptions of actual methods and systems. The serious student of Television going to take up the study of the subject will find the book extremely helpful. An excellent survey of the principles of both transmission and reception, particularly of the modern systems, is given. The treatment is logical and nonmathematical and the author has been able to bring home to the reader that Television to-day has passed the amateurish stage and has attained a sort of stability based on strict scientific principles. Inspite of the opinion expressed by the author that in an art like Television, which is changing so rapidly, detailed description of an actual working apparatus may soon become out of date we would have liked to see such discussion and description of some of the actual modern transmitting and receiving apparatus which are in more or less common use to-day. We hope it may be possible to include this in future editions of the book.

—H. K. R.

BOOK REVIEW

INTERMEDIATE PRACTICAL CHEMISTRY, *by Prof. P. B. Sarkar, D.Sc., Published by H. Chatterjee & Co., 19, Shamacharan De Street, Calcutta. Price 1/4 First Edition, 1938.*

This book is intended to meet the requirements of the Intermediate Students in practical chemistry. It fully covers the syllabus of the Calcutta University and Dacca Intermediate Board. The experiments have been very carefully drawn up and the description is very lucid and clear. The book seems fairly thorough and systematic, and the subject matter has been well arranged. The Intermediate students in science will have to appear at the practical examination from this session; and it is quite in the fitness of things that the author produced a really good book for the students. His book has been a distinct improvement upon the existing ones on the same subject and the students are sure to be benefited by this timely publication.

Besides the practical details, the book contains a world of useful information put in a popular way. This will go a long way to create a taste for chemistry for the beginner. The book is well bound but the printing leaves much to be desired.

P. K. D.

LAC CULTIVATION IN INDIA, *by P. M. Glover, B.Sc., Indian Lac Research Institute, Namkum, Ranchi, Bihar, India, 1937. Price Rs. 2/-.*

This is a practical manual of lac cultivation which is one of India's present day monopoly trades. This book deals with the entomological study of lac insects with their geographical distributions in various parts of the world. A statistical report is given about the increased production of lac grown in India, Burma, Bangkok and Singapore. Detailed methods which have been worked out at Namkum to combat lac pests, which are the chief destroyers of lac insects, are discussed. The different soil treatments with manures and fertilizers for the improved growth of lac hosts thus causing increased production of lac are described. This book is intended to give the necessary information regarding lac cultivation in India and is likely to be much valued by educated lac cultivators and owners for the improvement of lac production. This book may be recommended to all concerned.

Baidyanath Ghosh.

ANNUAL REVIEW OF BIOCHEMICAL AND ALLIED RESEARCH IN INDIA, *Vol. VIII. Published by the Society of Biological Chemists, India, Bangalore. Price Rs. 3 or sh. 6.*

The latest volume of the series has come to be regarded as a stock-taking of the progress of biochemistry and allied researches in India during the year 1937. This review deals in a nut-shell with all the contributions which workers in India and Indian research workers abroad have made to the advancement of biochemical knowledge during the last year. The different chapters include—Vitamins, Proteins, Enzymes, Pharmacology, Human physiology, Pathology and Bacteriology, Food and Nutrition, Microbiology and Fermentation, Plant Physiology, Chemistry of plant products, Phytopathology-Mycology, Phytopathology-Entomology, Soils, Fertilizers and Manures, Animal Nutrition and Dairy Science, Veterinary Science- which are written by specialists in their respective fields.

This Review can be confidently recommended to all, who wish to have a connected impression of the biochemical contributors by Indian workers. The presentation and printing are excellent and the book is remarkably free errors. There is a full bibliography with each chapter.

Baidyanath Ghosh.

LETTERS TO THE EDITOR

[*The Editor is not responsible for the views expressed in the letters.*]

Epidemic Dropsy and the Contact Infection Theory

In the investigations of Lal, Ray and Ghosal[1] on epidemic dropsy it has been stated that "as the number of rooms per person increases, the incidence (of epidemic dropsy) also rises, a finding which goes against the contagion theory," (p. 209). As this statement appeared to be *prima facie* very peculiar it was considered worth while to go into the statistical analysis employed which could lead to such a conclusion. It is difficult to imagine a disease whose incidence will increase with the decrease in congestion.

A scrutiny of the statistical analysis indicates that it is based on faulty methods. The analysis suffers from the following two errors:

(1) The partial correlation, the interpretation of which leads to the above conclusion, has been calculated according to a wrong method.

(2) No test has been applied to judge the significance of the partial correlation, which alone could have justified the above statement.

In working out a partial correlation same number of observations must be taken for all the variables and the same set of values for each variable must be used throughout. Neither of these conditions is fulfilled in the above analysis. The variables are - incidence, rooms per person and size of the family, the last variable being the one to be eliminated. The number of pairs of observation is 30 in one case and 16 in the other two cases. Moreover, the values of two of the variables, namely, incidence and rooms per person, have been found by one method in the first case and by an entirely different method in the other two cases. Thus the value obtained for the partial correlation is not a valid estimate nor does it enable us to apply any test of significance.

The correct value of the partial correlation, which can be obtained from the two tables containing 16 pairs of observations each, works out to be +0·3983 which is practically the same as obtained by the authors themselves, namely, +0·3976. This is merely a coincidence and should not be taken as a justification of the faulty method. Only 13 degrees of freedom are available for the correct value and Fisher's table[2] gives the expected 5% value as 0·5139, which shows that the partial correlation is not significant. Hence the statement quoted above is not justified. All we can say is that the evidence in hand does not contradict the hypothesis that for a family of a given size the incidence of epidemic dropsy is independent of the rooms per person.

12 B, Bakul Bagan Row, B. Chatterjee.
Bhowanipore, Calcutta.
20.6.1938.

[1] Lal, Roy and Ghosal, *Ind. Jour. Med. Res.*, *15*, 1, 163-259, 1937.

[2] Fisher, *Statistical Methods for Research Workers*, 4th ed., 188, 1932.

Efficiency of the "Entoray" Mosquito-Catching Machine

The inventor of the "Entoray" machine claims that if the machine is installed in a place it will catch most of the mosquitoes of the place and thereby reduce the incidence of mosquitoes in the surrounding areas within a specified radius. Senior White[1] *et al* have tested the efficiency of the machine and one of their conclusions is that "it is not capable of making any statistically significant difference in mosquito incidence even within a few feet of its point of operation," (p. 629).

A scrutiny of the data and the statistical analysis thereof shows that the experiment was not designed properly and the methods employed in the analysis suffer from serious defects. The following table gives the total hand catches of male mosquitoes for five consecutive years in experiment III (A).

Experimental Area		*Control Area*	
1-22 wks.	23-30 wks.	1-22 wks.	23-30 wks.
346	271	326	269
105	193	92	64
99	99	41	45
82	163	55	80
67	82	81	46

If we compare the figures of 1-22 weeks for the two areas, when no machine was working in either area, it will be seen that while the incidence of mosquitoes was steadily falling in the experimental area, in the control area the incidence was rising since the fourth year. Moreover, in the fifth year the total catch in the control area rose for 1-22 weeks and fell for 23-30 weeks. This shows that some unknown cause has been operating in the control area which was probably

absent in the experimental area. As the actual experiment with "Entoray" was carried out in the fifth year, the value of the second area as a control is extremely doubtful.

Figures for 30 weeks for each of the five years were used in the statistical analysis which was carried out separately for the male and the female mosquitoes. Expected weekly values for the fifth year were obtained by extrapolating from straight lines fitted to four figures for each week. Deviations of the expected from the observed values in the fifth year were worked out. The mean of these deviations for the first period, namely, 1-22 weeks when the machine was not working, was compared with the mean for the second period, namely, 23-30 weeks when the machine was working. Fisher's t test[1] was applied to test the significance of the difference between the means of the two periods. The results of this test could not bring out any significant difference caused by the machine.

The above method of analysis is faulty for the following reason: -

No test has been applied in order to judge the significance of the straight line regressions. As a matter of fact, excepting a very few, the regressions are all insignificant even at the 5% level. Hence there is no justification for working out the expected values from the straight lines.

As anti larval measures over a wide area were started only from the second year, the best procedure under the circumstances is to take the mean of the values of the second, third and fourth years as the expected value for the fifth year. As the incidence of mosquito during the earlier weeks is rather small, it is better to leave out the figures for first few weeks. This will ensure homogeneity of the figures for each period. In the following table the non machine period has been taken both as 1-22 weeks and 16 to 22 weeks (the figure 16 has been taken arbitrarily).

	Male.			Female.		
	1-22 wks.	16-22 wks.	23-30 wks.	1-22 wks.	16-22 wks.	23-30 wks.
Mean dev. (Exp.-Ob.)	1·3	2·8	8·7	2·7	9·7	17·2
Difference	7·4	5·9		14·5	7·5	
Standard error	1·41	2·36		2·88	3·86	
Degrees of freedom	28	13		28	13	
t	5·23	2·50		5·03	1·94	

Comparing these observed values of t with those expected by chance alone, as given by Fisher,[2] we find that the results are highly significant for both males and females, if 1-22 weeks be taken as the non-machine period. If, however, we take 16-22 weeks as the non-machine period, moderately significant result is obtained in the case of males and no significance is brought out in the case of females. Hence, on the whole it will be safe to say that the machine has reduced the incidence of male mosquitoes, while its effect on the female mosquitoes is doubtful.

In the analysis of figures of experiment III (B) also a faulty method has been adopted. In obtaining the values of χ^2 mean frequencies have been used which is fundamentally wrong. Only total frequencies should be used in χ^2 test. The correct values of χ^2 are highly significant with a positive correlation in the case of males and a negative correlation in the case of females. Thus in the case of males the machine appears to increase the incidence and in the case of females the machine decreases the incidence. The second result is definitely in favour of the machine but the first seems to be somewhat improbable. The figures for the males suggest that the control area is under some unknown influence which probably is absent in the experimental area. Thus the figures for the control area do not provide us with good control figures for the males at least.

We are, therefore, led to the following conclusions: -

(1) The experiments were not properly planned;

(2) Defective statistical methods were applied in analysing the data which led to some positive statement against the machine.

(3) A proper analysis of the data establishes the efficiency of the machine at least in some cases.

12 B. Bakul Bagan Row,
Bhowanipore, Calcutta,
20-6-1938.

B. Chatterjee.

[1] Senior White, Lal, Adhikari, Swaroop—*Rec. Mal. Su Ind.*, 6, 595-629, 1936.

[2] Fisher, *Statistical Methods for Research Workers*, 4th ed., 151, 1932.

Resistivity of Thin films: Caesium

In the last issue of this journal[1] an expression for the dependence of electrical resistivity on the thickness of metallic films was derived on the assumption that electrons colliding with either boundary suffer random scattering, and the formula obtained, *e.g.*,

$$\rho_t = \frac{\rho_\infty}{1 + f(t/\lambda)} \qquad \ldots \quad (1)$$

where ρ_t is the resistivity for thickness t,
ρ_∞ " " " bulk material
λ " electronic mean free path in bulk material

and $$f(t/\lambda) = \int_0^1 e^{-(t/\lambda z)} dz$$

was applied to Lovell's[2] measurements of Rb films. It is proposed to apply the same to Lovell and Appleyards'[3] measurements on Cs films. The following table presents the observed, as well as the calculated values of ρ_t.

$T = 64°K$, $\lambda = 1450Å$

t in A	5	10	15	20	30	40	50	75	100	200	300	400	500	∞
$\rho_t \times 10^6 \Omega$ (expt.)	246·9	140·7	87·9	46·9	24·7	17·3	15·0	13·8	11·8	10·8	9·9	9·9	9·4	4·0
$\rho_t \times 10^6 \Omega$ (Lovell's formula)	172·8	98·7	69·1	54·3	39·5	32·1	27·1	18·7	15·8	8·8	6·9	5·9	5·9	..
$\rho_1 \times 10^6 \Omega$ (formula 1)	210·0	105·3	76·3	60·6	44·7	36·0	30·3	22·6	18·6	11·7	9·2	7·8	7·1	..

It would appear from the table that ρ_1 tends to remain constant beyond 300 A, but actually it decreases very slowly and an accurate estimate of its value after 300 A was not possible from the graph in Lovell and Appleyards' paper. It will be observed that formula (1) fits in with the observed data rather well except for the intermediate region 20 to 100 A where the discrepancy between the observed and calculated values is quite as pronounced as rather more so than, in case of Lovell's formula. It is of particular interest to note in this connection that recently Fuchs[4] has worked out an elaborate expression to account for the increased resistivity of films. He has considered cases of random scattering as well as those of partially elastic scattering with different reflection coefficients. Comparing his results for random scattering with ours, we find that according to him also, for values of $t < 15$ or 20 A, the assumption of random scattering suffices to bring about satisfactory agreement with the observed data. As thicknesses exceed some 200 A°, Fuchs concludes that surfaces again increasingly favour random scattering. For the intermediate region 20 to 200 A° choosing suitable values of reflection coefficients i.e., different degrees of elastic scattering, he obtains as close agreement with observation as desired, though it must be remarked that it is somewhat peculiar that colliding electrons at the surface will behave one way when the film is either very thin or thick and another way for intermediate regions.

Further details will be published elsewhere.

Indian Association for the Cultivation of Science,
210, Bowbazar Street, Calcutta.
B. Mukhopadhyay.

10-7-38.

[1] *Science and Culture*, May 1938, p. 626.

[2] A. C. B. Lovell, *Proc. Roy. Soc.* A 157, p. 311.

[3] Appleyard, E. T. S., and Lovell, A. C. B., *Proc. Roy. Soc.* A Vol. 158, p. 718.

[4] Fuchs, K., *Proc. Camb. Phil. Soc.*, 34, p. 100, 1938.

The Structure of Sulphur Particles in Colloidal Suspension in Water

It has been reported[1] previously that the spontaneous solid deposits of colloidal sulphur formed as a result of a very slow process of sedimentation, as well as the electrolytic deposit obtained on addition of a requisite quantity of NH_4OH of proper concentration to the colloidal solution are crystalline and their structures are exactly similar to that of orthorhombic sulphur or S_α.

In order to arrive at a definite conclusion about the real nature of the colloidal sulphur particles in the state of suspension several attempts were made also to study the solution by X-ray diffraction method,[1] but they were all unsuccessful.[1]

Recently we have been able to come to a very definite conclusion as regards the nature of colloidal sulphur particles suspended in water. A totally new method of studying less volatile liquids by the X-ray diffraction method has been developed, which involves in exposing the liquid in small drops to the incident radiation. With the arrangements made, it was possible to control the size of drops, which in our experiment was of the order of a millimeter. We found that in the case of colloidal solution of sulphur, a drop of the above mentioned size remained, on an average, undisturbed and practically unchanged for more than half-an-hour inspite of the mechanical disturbances due to the constant working of the pumps and other sources.

It is also worth mentioning here that no change in the quality of the solution was noticed and we have also not been able to observe any trace of coagulation of sulphur particles and the consequent quick deposition of sediments in the colloidal solution under the influence of X-rays. To test this point a set of preliminary experiments were necessary. For, if the deposition of sulphur takes place in this condition, any crystalline pattern obtained may be due to these deposits and no definite conclusion regarding the nature of the suspended sulphur particle may be arrived at.

A quantity of the solution was enclosed in a thin-walled glass tube of about 1·5 mm. bore. The tube was sealed at both ends and exposed to the X-rays (5m. amp at 35 K.V) for about 10 hours. No sign of sedimentation or any other change could be detected.

The photographs obtained with colloidal sulphur drops exhibited a crystalline pattern but the back ground was very diffuse owing to the scattering of X-rays by the water molecules in the solution. Measurements of the sharp rings and the visual estimation of the relative intensities definitely show that the colloidal particles in the state of suspension are

also crystalline like ordinary S_α. The detailed description of the method and the result will be published in the *Indian Journal of Physics*.

Khaira Laboratory of Physics, University College of Science, Calcutta.
20-6-38.

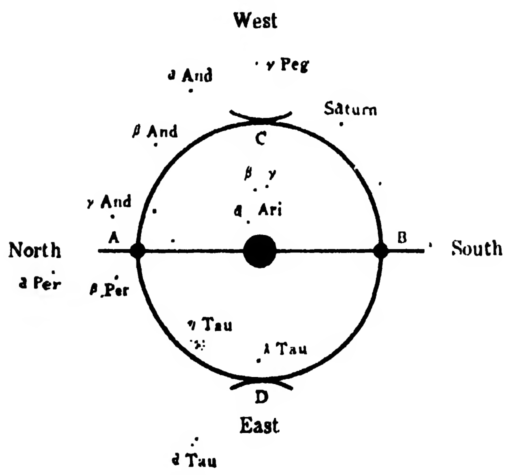
S. R. Das.
K. Ghosh.

[1] *Ind. Jour. Phys.*, July. 1938.

A Lunar Halo with Partial Parhelic Circle and 'Horizontal' Arcs seen at Hyderabad

At about 4 A.M. of 24th June 1938, I witnessed what was undoubtedly an incomplete system of lunar halos, with parhelic circle and so-called 'horizontal' arcs—a phenomenon visible generally in very high latitudes. A rough sketch of the apparition giving the position of the moon in the eastern sky is enclosed herewith.

The first inner halo circle of *white* colour and about 22½° radius was complete; the parhelic circle passing through the moon and the points A, B, extended a couple of degrees beyond its points of intersection with the halo. Its portion inside the halo was faint, and at the points A, B, it presented the appearance of somewhat roundish bright patches.



There was *no* second halo circle of 45° radius, nor was there any semblance of the so-called 'vertical' line passing through the moon, at right angles to the parhelic circle. But at C—the topmost point of the halo, there was a short bright (the so-called 'horizontal') tangential arc, concave upwards, towards the west.

By 4·30 A.M. the lower (eastern) part of the halo was well above the horizon. At D its lowest point, a short, fairly bright (the so-called 'horizontal') arc, slightly concave downwards (towards the east), was discernible.

All the time the sky was covered with a uniform, thin veil of haze. After 4.30 A.M., the southern part of the haze thickened into clouds, the bright spot at B disappeared and the whole system vanished not long afterwards.

On the evening of the 22nd June, there was a good downpour of rain and the night of the 23rd was cold and chilly. The haze on the morning of the 24th was presumably due to minute snow crystals in the upper atmosphere, which gave rise to the unusual halo.

Begumpet, a suburb of Hyderabad, Deccan, has latitude 17° 25′ 54″ North and altitude 554 metres.

Begumpet,
Deccan, N. S. R.
10 7 38.

Mohd. A. R. Khan.

The Separation of Neurotoxin from the Crude Cobra (Naja Naja) Venom

Starting with a sample of crude cobra venom the m.l.d. of which for pigeons (300 g) was 0·3 mg. it has been shown by us[1] that the neurotoxin could be concentrated in a protein fraction which constitutes only 5·2 per cent of the protein content of the crude venom, or 1 mg. of the purified product contained 59·6 m.l.d.

Recently we have obtained a sample of cobra (Naja Naja) venom which is three times more active than the venom which we used previously. Experiments were therefore undertaken to separate the neurotoxin from this active sample.

A one per cent venom solution is first precipitated at 22 per cent sodium sulphate concentration as mentioned previously (*loc.cit*). The filtrate then precipitated at 29 per cent sodium sulphate concentration by the addition of more 44 per cent sodium sulphate solution. The mixture is filtered and the filtrate is treated with more solid sodium sulphate so as to bring the concentration of the salt to 36 per cent. The precipitate formed is separated by filtration. The active principle in the filtrate is precipitated by sodium tungstate and sulphuric acid and eluted as described in a previous paper by Ghosh and De.[2] In this way a sample was obtained in which 1 mg. of protein was associated with 106 m.l.d. When, to 8·5 mg. of this product, dissolved in 4 c.c. of ice-cold water, adjusted to pH 2·8, 8 c.c. of ice-cold methyl alcohol is added a precipitate is formed.

This precipitate containing the active principle is separated by centrifuging and then washed with cold 66 per cent methyl alcohol. It is found that 124 m.l.d. are associated with one mg. of protein of this precipitate. The purified neurotoxin sample which we obtained previously starting with a crude venom sample (m.l.d. 0·3 mg.) contained only

59·6 m.l.d. per mg. of protein. Therefore our new preparation is 2·06 times more active than the one reported previously.

Applied Chemistry Department,
University College of Science,
Calcutta.
8-7-38.

B. N. Ghosh.
S. S. De.
N. L. Kundu.

[1] *Science and Culture*, 2, 585, 1937.
[2] *Ind. Jour. Med. Res.*, 25, 3, 1938.

Note on the use of Mercury volume-meter for the determination of Specific Gravity of Timbers

The methods usually employed in determining the volume of a small specimen of timber are

(1) by measuring dimensions of the specimen and then calculating its cubic content;

(2) by displacement of water;

(3) by displacement of mercury;

(4) by displacement of any other liquid of known specific gravity.

Of these the first method is very simple and direct; and a number of measurements are needed for accurate results. The second method is widely used, but it must be emphasized that the timber specimen in this case is always associated with a certain amount of moisture absorption, and a consequent discrepancy in the results. The method is particularly useless at different stages of progressive drying. The practice of coating specimens with paraffin involves further error in more than one way.

Of instruments depending on the use of mercury, the Breuil mercury volume meter is very popular. The instrument is so designed that it records the volume in cubic centimeters, and the specific gravity is computed from

$\frac{W}{V \times d}$ where W=weight of the specimen in air,

V=volume recorded by the volume-meter,

d=density of water at the temperature of the experiment.

This method apparently looks very simple. But the trouble with this method is that it is not at all easy to recover all the mercury that penetrates into the timber pores. There is always left some amount of mercury inside the specimen, a matter which should not be overlooked. Besides, as a result of some mercury filling pores, the reading recorded by the volume-meter cannot give a correct value for the amount of mercury displaced. Consequently, a correction must be made to the above formula in order to arrive at a true value of the specific gravity of the specimen under examination, and the following formula was found to be best suited for the purpose :

$$\text{Specific gravity} = \frac{W_1}{\left(V + \frac{W_2 - W_1}{\text{density of mercury at the temp. of exp.}}\right) \times \text{density of water at the temp. of exp.}}$$

where W_1=weight of specimen in air,

V=volume recorded by volume-meter,

W_2=weight of specimen in air after mercury displacement.

The Robertson-Brown displacement bottle also makes use of mercury, but was found to be not so accurate as the Breuil volume-meter when worked out as above.

Very little work has been done to determine the specific gravity of timbers by the displacement of some other liquid of known density. The results are likely to be affected because of the absorption of liquid by the wood, or the solvent action of the liquid on the ingredients of the timber, or both.

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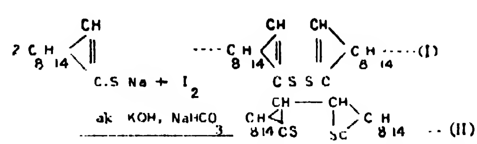
B. N. Mitra.

On a New Rearrangement in the Thiocamphor Series

By the action of iodine on sodiothiocamphor in benzene, two products are obtained, an unsaturated disulphide (I) b.p. 160°/10 m.m., and an 1:4 dithioketone, bisthiocamphor (II) m.p. 180°. The compound (I) is obtained if the reaction is allowed to take place at 0°, and the product is isolated at once from the reaction mixture. But if iodine is added to sodiothiocamphor in boiling benzene, and the product isolated after 15-16 hours, bisthiocamphor (II) results.

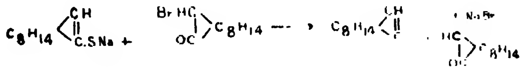
The disulphide (I) does not react with hydroxylamine, but gives tests of unsaturation, whereas the dithioketone (II) gives a dioxime and an azine, thus confirming the presence of two C:S- groups. The disulphide (I) when kept in cold for 2-3 days in contact with alcoholic potash (20%) is changed into the dithioketone (II). The same rearrangement is also effected by heating the disulphide with a saturated solution of sodium bicarbonate or even with a saturated solution of sodium thiosulphate for 5-6 hours. The reaction of iodine on sodiothiocamphor can therefore be represented as follows:



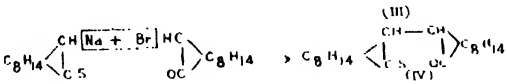
That sodiothiocamphor reacts in the thiolic phase during the formation of bisthiocamphor is also corroborated by the

LETTERS TO THE EDITOR

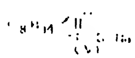
isolation of a sulphide, (III) by the interaction of α-Bromocamphor and sodiothiocamphor according to the following reaction:



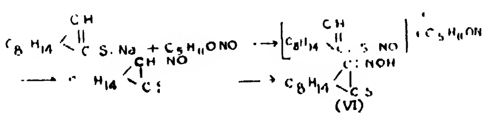
Had sodiothiocamphor reacted in the thioketo phase then thioketone (IV) would have been expected.



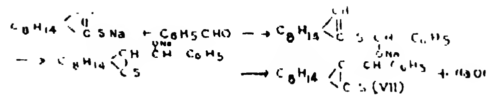
While the paper on bisthiocamphor was published[1] the author explained the reaction by the assumption of a C-Na thiocamphor analogous to C-Na-Camphor. But the above observation leaves no doubt as regards the constitution of sodiothiocamphor as well as the mechanism involved in the formation of bisthiocamphor. Attempts were also made to isolate C-alkyl-and C-acyl derivatives of thiocamphor, but it has been observed that S-alkyl and S-acyl derivatives are exclusively formed by the action of alkyl iodides and acyl chlorides respectively on sodiothiocamphor. It has also been observed that α-halogenated esters, *e.g.* Bromoacetic ester, α-Brom propionic ester, Bromo malonic ester etc., give rise to S-substituted derivatives with sodiothiocamphor. It is therefore definitely established that sodiothiocamphor unlike sodiocamphor behaves only in one phase and its constitution can be represented by (V).



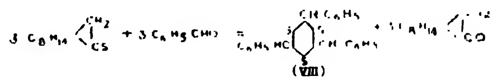
According to this assumption, the formation of all the C-substituted derivatives of thiocamphor can be ascribed to a rearrangement of radicals from sulphur to carbon through the unstable intermediates which could not be isolated. The formation of iso-Nitroso thiocamphor[2] (VI) accordingly, is now represented as follows:



The formation of Benzylidene derivatives[3] (VII) of thiocamphor by the action of benzaldehyde on sodiothiocamphor can be interpreted as follows:—



Alkali appears to be responsible for the above type of rearrangement, for if the condensation of aldehydes and thiocamphor be allowed to take place in presence of alcoholic hydrochloric acid, the reaction takes a different course with exchange of radicals, camphor and trithio benzaldehyde (VIII) m.p. 226° being the products of reaction:



The exchange of oxygen for sulphur in benzaldehyde is nothing unusual and has also been observed by Mitra,[4] in the case of thioacetoacetic ester.

My sincere thanks are due to Dr P. K. Bose for his kind interest in this investigation and also for the facilities of his laboratory.

The details of these results will be published in due course in the *Journal of the Indian Chemical Society.*

Chemistry Department,
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and Technology,
Calcutta.
21.6.38.

Dines Chandra Sen.

[1] Sen, *J. Ind. Chem. Soc.*, *14*, 213, 1937.
[2] *Ibid.*, *12*, 751, 1935.
[3] *Ibid.*, *13*, 523, 1936.
[4] Mitra, *J. Ind. Chem. Soc.*, *9*, 633, 1932.

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The Congress President on National Reconstruction

ELSEWHERE in this issue, we publish a momentous pronouncement by Mr Subhas Chandra Bose, President of the Indian National Congress, on the National Reconstruction of India. The Congress President advocates, in unequivocal terms, for a large scale industrialisation of the country, as the only sure remedy for solving the problems of poverty, unemployment and defence. He also outlines a clear-cut scheme for large scale industrialisation. When the National Government comes, says Mr Bose, it should adopt a policy of development of the mother industries *viz.*, of power supply, production of metals, of tools and machineries, and of essential chemicals and of materials essential for transport and communication. It should also train up the necessary technical staff, and set up a National Research Council. Mr Bose suggests that a National Planning Board, composed of eminent scientists, industrialists, and public men should be set up immediately to draw up detailed schemes of promotion of mother industries.

We believe that the President has given the much wanted lead to the country and his advice should be accepted by the Conference of Industry Ministers of the Congress Provinces which is shortly going to meet under his Presidency at Bombay. We hope further that the conference would not break up after merely passing pious resolutions, but should actually bring into existence the National Planning Board to draw up a detailed report on large scale industrialisation. This report, which we think will take from about six months to a year to take shape, will serve as a guide not only to the Congress Provinces but also to others, and the Central Government. We hope that the Report will create a clarity of vision and a correct definition of ideal, point out the true path, and thus remove the embarassing confusion of thought now prevailing all round the country.

The magnitude of the confusion of thought and its paralysing action is not, we are afraid, properly realized. We take only one example, the Industries Minister of one Congress Province expressed recently his determination to effect largescale industrialisation, but a little later in his speech, we were dismayed to find out that by largescale industrialisation, he means cardboard manufacture and soap-making. He did not probably realize that these are very minor industries, and their introduction and success as well as those of many others depends on cheap supply of power, of essential chemicals, and of raw materials; if supplies of these are ensured, the minor industries would grow spontaneously without any state effort. To use a metaphor, the ministers are not attending to the root and stem of the tree but to the foliage. They forget that if the root is properly watered, the foliage will take care of itself. But at the present times, the Government exercise no substantial control over these key (or mother) industries and have

allowed them to fall under private hands. At any moment, these small scale industries where they exist may be killed by corporations which control the mother industries. Further, these ministers, being new to their task, and being unable to obtain the necessary technical advice from their subordinates, have not been able to obtain the proper perspective with respect to industrialisation. The confusion is further accentuated by uncritical newspaper propaganda, and by the patting-on-the-back-of such propagandists by highly placed persons. Mr Bose has very pointedly exposed the hollowness of the claims of a director of industries who, having introduced, according to his own version, a cheap method of manufacturing umbrella handles, and bell-metal goods, tried to create the impression that he has brought on industrial regeneration for the province. We are afraid that he is not the only specimen of his class.

In strange contrast to the clarity and boldness Mr Bose's pronouncement is the official policy of industrialisation, or tinkering with industrialisation which is exposed in another article in this journal "Technical Aid to Industries by the Government of India." This will convince all readers that the men who have been so long responsible for the administration of India want Indians to grow nothing but 'potatoes and tobacco.' Strangely enough, they are supported, though not orally, but by their action, by the extreme section of the Congress who advocate a return to the primitive forms of life to the bullock cart, spinning wheel, and the home-spun.

We hope that Mr Bose's pronouncement will create the proper perspective, and if it is further backed by the report of the National Planning Commission, will chalk out the proper line of action. Let us also hope that the pronouncement will cut the Indian Nation adrift from the philosophy of the bullock cart to which it has so long been tethered, on account of an incorrect appreciation of the importance of industries to the Nation.

We do not minimise the evils that have crept into the modern capitalistic-cum-scientific world. But these evils have arisen, because man has gained considerable control over forces of nature before he has gained moral control over his own self. The developing miracle of science is at our disposal to use or to abuse. But what should not be forgotten is the fundamental fact, that if popular leaders and popular governments are as intelligent and far-sighted as Mr Bose, if business men are more disinterested, and if we all work for social welfare and social justice, we can, with the aid of science, enter into an era of plenty and prosperity; where every man and woman in India can live in comfort which would have been the envy of Emperor Shahjehan. Biologically speaking, life is a continuous process of adjustment and the tempo of modern scientific progress demands that the rate of such adjustment should be very considerably accelerated in India. The tradition should disappear that each generation should live more or less under conditions which governed the lives of its fathers and should transmit to the next generation similar conditions of living. We wish to hold up before every intelligent man and woman in this country this vision of new adjustment. Such a psychological change alone will give us the strength to overcome the enormous difficulties that beset our path in the evolution of the Indian Nation.

Address of the Congress President—Mr Subhas Chandra Bose

I AM deeply grateful to you for the honour you have done me by inviting me to the annual meeting of the Indian Science News Association, which is responsible for publishing the well-known scientific journal, "Science and Culture." You can imagine my feelings in the midst of such a highly intellectual and cultured audience. But though I feel utterly ignorant and small in such a company, I welcome the occasion for more reasons than one. In the first place, I have a very high appreciation of this valuable work that is being done by SCIENCE AND CULTURE. Secondly, it is a privilege to meet such distinguished scientists and have an opportunity of exchanging ideas with them. Thirdly, it affords me some relief from the monotony and drudgery of my daily life and enables me to breathe a healthy, intellectual atmosphere though for a short while. Last but not the least, I am greatly interested, as all of you undoubtedly are, in the application of science to the problems of national reconstruction.

The movement for Indian emancipation has reached a stage when Swaraj is no longer a dream —no longer an ideal to be attained in the distant future. On the contrary, we are within sight of power. Seven out of eleven provinces of British India are now under Congress Ministries. Limited though the powers of those governments are, they have yet to handle the problems of reconstruction within their respective domain. How are we to solve these problems? We want, first and foremost, the aid of science in this task.

The Congress and the Task of National Reconstruction

I have always held the view and I said so in my presidential speech at the Haripura Congress, that the party that fights for freedom cannot liquidate itself when power is won. That party should face the task of post-war reconstruction as well. Hence, Congressmen of to-day have not only to strive for liberty, but they have also to devote a portion of their thought and energy to problems of national reconstruction. And national reconstruction will be possible only with the aid of science and our scientists.

The President is wholeheartedly for Large-scale Industrialisation

May I now, with your permission, place before you some of my ideas on the problems of national reconstruction? We hear very often now-a-days of schemes for bringing about industrial recovery in this land. An officer in this province recently wrote a voluminous book on a recovery plan for Bengal. Problem we have to face is not industrial recovery, however, but industrialisation. India is still in the pre industrial stage of evolution. No industrial advancement is possible until we first pass through the throes of an industrial revolution. Whether we like it or not, we have to reconcile ourselves to the fact that the present epoch is the industrial epoch in modern history. There is no escape from the industrial revolution. We can at best determine whether this revolution, that is industrialisation will be a comparatively gradual one, as in Great Britain, or a forced march as in Soviet Russia. *I am afraid that it has to be a forced march in this country.*

The Need of a National Planning Commission

I have no doubt that when we have a national government for the whole country, one of the first things we shall have to do is to appoint a National Planning Commission for the whole country. As a matter of fact our ministries in the seven provinces have already been feeling the need of a uniform industrial policy and programme. Anticipating this, the Congress Working Committee passed a resolution a year ago, soon after the Congress ministries came into existence to the effect that it was necessary to appoint a committee of experts to

advise the Congress Governments on industrial matters. This view was confirmed by the Congress Premiers' Conference which met in May, 1938, in Bombay under my Chairmanship. Thereafter, the appointment of the Committee of Experts has been before the Working Committee and at its last meeting in July, the Working Committee decided that as a preliminary step, I shall convene a conference of the Industries Ministers of seven Congress-administered provinces. I am stating all these facts to show that without waiting for the advent of Purna Swaraj, we are moving in the direction of economic planning.

Though I do not rule out Cottage Industries and though I hold that every attempt should be made to preserve and also revive Cottage Industries wherever possible, I maintain that economic planning for India should mean largely planning for the industrialisation of India. And industrialisation, as you will all agree, does not mean the promotion of industries for manufacturing umbrella-handles and bell-metal plates, as Sir John Anderson would have us believe.

I gratefully recognise the fact that your magazine SCIENCE AND CULTURE has helped to direct intelligent thoughts in this country towards the problems of industrialisation. The articles published periodically on Electric Power Supply, Flood-control, River-physics, Need of establishing a National Research Council etc. have been highly illuminating and instructive.

Principles of National Planning Outlined

I should now like to make a few observations on the principles of National Planning.

1. Though from the industrial point of view the world is one unit, we should nevertheless aim at national autarchy, especially in the field of our principal needs and requirements.

2. We should adopt a policy, aiming at the growth and development of the mother industries *viz.*, power-supply, metal production, machine and tools manufacture, manufacture of essential chemicals, transport and communication industries etc.

3. We should also tackle the problem of technical education and technical research. So far as technical education is concerned, as in the case of Japanese students, our students should be sent abroad for training in accordance with a clear and definite plan so that as soon as they return home, they may proceed straightway to build up new industries.

So far as technical research is concerned, we shall all agree that it should be freed from governmental control of every kind. It is only in this unfortunate country that government servants are entrusted with scientific research on receipt of princely salaries and we know very well what results have been obtained therefrom.

4. There should be a permanent National Research Council.

5. Lastly, as a preliminary step towards national planning, there should be an economic survey of the present industrial position with a view to securing the necessary data for the National Planning Commission.

These are, in brief, some of my ideas on the problems of industrialisation and national reconstruction and I believe they are held in common by scientific men and women in this country. We, who are practical politicians, need help from you, who are scientists, in the shape of ideas. We can, in our turn, help to propagate these ideas and when the citadel of power is finally captured, can help to translate these ideas into reality. What is wanted is far-reaching co-operation between Science and Politics.

Divergence of Views in Congress Ranks

Prof. Saha has in the course of his illuminating address, asked me what the attitude of the Congress is towards the problem of industrialisation. I must say that all Congressmen do not hold the same view on this question. Nevertheless, I may say without any exaggeration that the rising generation are in favour of industrialisation and for several reasons. Firstly, industrialisation is necessary for solving the problem of unemployment. Though scientific agriculture will increase the production of the land, if food is to be given to every man and woman, a good portion of the population will have to be transfered from land to industry. Secondly, the rising generation are now thinking in terms of Socialism as the basis of national reconstruction and Socialism

presupposes industrialisation. Thirdly, industrialisation is necessary if we have to compete with foreign industries. Lastly, industrialisation is necessary for improving the standard of living of the people at large.

Question of Fundamental Unity of India

Prof. Saha has asked another question *viz.*, whether India will be one nation when she is freed from British control. To this I may reply that we of the Congress are conscious of our responsibility in the matter of achieving Indian unity and solidarity. We want to go, not the way of China but the way of Turkey. But we shall have to work very hard indeed, if we want to hold together as one nation when we are free. For promoting national unity and solidarity, many things are needed *viz.*, a common lingua franca, a common dress, a common diet etc. The Congress, as you are aware, has been advocating Hindustani as the lingua franca of this country. But I believe that what is wanted most of all is the will to be one nation and to hold together as one nation, when foreign domination ceases. Thus, to my mind, the problem of unity is largely a psychological problem. The people must be educated and drilled to feel that they are one nation. Other factors, like language, dress, food etc. may help unity, but cannot create it. In addition to this national will, what is needed for maintaining national unity and solidarity is an all India party. That party is the Congress. We find in history that each country has produced a party for the purpose of unifying the people of that country. The Communist Party in Russia, the Nazi Party in Germany, the Fascist Party in Italy, Kamal's Party in Turkey are instances in point. The Congress Party in India will play the unifying role which the above parties have played in their respective countries.

Let me, in conclusion, thank you once again for inviting me to this function this evening. May "Science and Culture" have a long useful and prosperous career in the service of the nation and humanity and may the generous public come forward enthusiastically to support this venture by enlisting as subscribers, by making liberal donation and in other ways.*

* Delivered on the occasion of the Anniversary Meeting of he Indian Science News Association, 1938.

A Chinese Philosopher on Principles of Education

A country's education is in principle the same as an individual's. A father or elder brother in arranging their son's or younger brother's education determines his approach according to whether he is to be a scholar, farmer, artisan, or merchant.... If he is to make baskets, they will not teach him something else....So with a country and its public education. The education is the means by which it nurtures its own kind of people, welding them together as a whole that they may be independent and struggle to survive in this world where victory goes to the fit and defeat to the unfit. To achieve this end is impossible with daubs of easternism and westernism, to-day learning some foreign language, to-morrow establishing some special study, in slipshod confused fashion hoping to reap the fruits. Those who have a mind to this great business of education must first recognise the two principles of education, the one the tool for manufacturing the people of the country, the other an indispensable means for understanding the world's experience, for examining the tendencies all over the world and the special characteristics of our own race with a view to arousing its whole strength.

Liang Ch'i-Ch'ao.

The Development of Electrical Power in the United Provinces

A. N. Tandon

Department of Physics, Allahabad University.

THE development of electrical power is a very important problem, and every country in the present state of economic struggle has to give the fullest attention to it. As a matter of fact, the degree of civilization of a country is now measured by the quantity of power a large part of which is bound to be electrical which it produces. Electrical power is now-a-days consumed for industrial purposes, for domestic use (lights, fans, and heating) for traction (electric trains) and for agriculture. The figures for all the prosperous and independent countries have shown that the industries alone consume the major part of the total power supply (more than 80%).

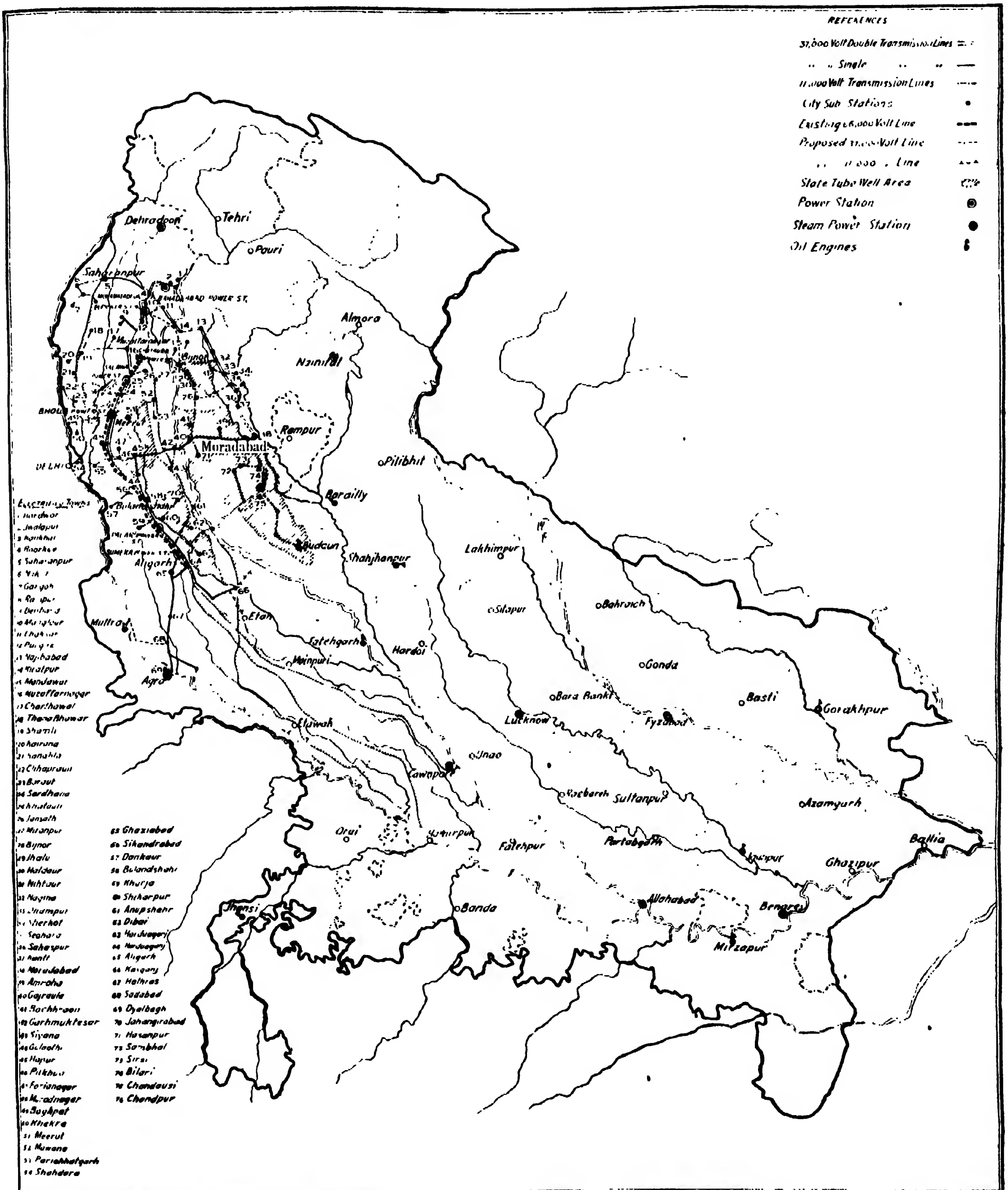
It is, therefore, evident that the question of development of industries is closely linked up with the problem of cheap power supply. This is all the more important for the development of small-scale cottage industries, which can never prosper without a cheap supply of electricity. I can cite here the example of Japan where more than 50% of the industrial output is from cottage industries, but these cottage industries are not worked by primitive machinery and manual labour, but by the up-to-date machinery. The use of up-to-date machinery is possible when the State has assured a cheap supply of electrical power. Electrical power has superseded all other forms of powers as it has some advantages not possessed by others. It is, therefore, no wonder that the attention of the public of our province has been drawn to the problem of cheap generation and distribution of electricity. The Government of the United Provinces has recently appointed a committee to investigate into a few aspects of this problem dealing mainly with the question of tariffs, but it is regrettable that the questionnaire issued by them shows a woeful bankruptcy of ideas on the part of the mentors of Government. The questionnaire shows that the mentors want the attention of the public to be diverted, to use a figurative language, to the foliage of a tree and not to its root. What is wanted is a thorough examination of the question of generation and supply from the national point of view.

The present state of electrical supply in the province is hopelessly antiquated. It looks upon electricity as an article of luxury, and the supplies in the big cities have been entrusted to electric supply companies on terms, which are extremely unfair to public interests, and retard the growth of industries.

The public supply of electricity in this province probably begins from 1915, and a few years ago it was confined to a few big cities like Cawnpore, Lucknow, Allahabad, Agra, Benares and Gorakhpur. These cities have still got their old supply companies. Besides the above-mentioned cities electricity is also supplied in some district head quarters by oil engine plants (capacity 250 kw-1000 kw). With the exception of Cawnpore, the consumption of electricity in most of the cities is confined to domestic use (light and fan), municipal supply, *i.e.*, (street lighting and power for water works) and for small plants like flour mill, etc. With the inauguration of the Ganges Canal hydro-electric project, the idea of rural electrification has also been introduced and in several western districts of the province many small towns having populations of about 5000 and over have been supplied with electricity. The present state of electrification is shown in the map on the next page.

No reliable estimate of the total installed power in these provinces is available but my estimate is that at present the total capacity installed in the

ELECTRICAL POWER DEVELOPMENT IN U. P.



province is about 65000 kw. including small oil engine plants and the hydroelectric power. The total consumption per year cannot exceed 200 million units and the consumption per head of population is approximately 4 units per year. Even in Japan where the natural power resources are not so plentiful, the consumption per head is about 400 units per year. This shows the backwardness of a major province of India in the matter of electricity supply.

Out of the total installed power, 29000 kw. are installed in the Ganges Canal hydroelectric grid. I shall, therefore, proceed to describe this grid system in detail.

The water of the Ganges canal in its course from Hardwar to the plains passes over 12 falls, which range in height from 7 to 10 ft. Most of these falls are situated between Hardwar and Meerut, and one is situated at Sumera near Aligarh. The Government of the United Provinces, under the persuasion of the chief engineer of Irrigation, Sir William Stampe, decided in 1926 to obtain electrical power from these falls and the present grid system is an outcome of that scheme. It has been developed in these stages, the details of which can be read in an article by Sir William Stampe published as a supplement of the *Leader* dated November 4. At the present time electricity is generated at seven falls and the capacity installed of the stations is as follows:—

Bahadurabad and Salempur (4×600 + 2×1000)	..	4,400 kw
Mohammadpur (2×2000)	..	4,000 „
Chitaura (2×1500) ..	..	3,000 „
Salawa (2×1500) ..	..	3,000 „
Bhola (4×375) 1929 .. (2×600) 1934	..	2,700 „
Palra (3×200) ..	..	600 „
Sumera (2×600) ..	..	1,200 „
Total		18,900

Besides these, there are stand-by steam plants at Chandausi having an installed capacity of 9000 kw. and several other small oil engine generators (total capacity 1885 kw.) at Moradabad (500 kw.), Saharanpur (250), Meerut (250), Tundla (200), Aligarh (200), and Lhaksar (75). These stand-by stations are meant to supply electricity when the water supply in the river becomes insufficient during the dry season. It will be noticed that their capacity exceeds one-third of the total power developed by the grid.

All the above plants which are situated at fairly large distances are interconnected by high voltage transmission lines. These lines are shown in the map. Out of the total generating capacity of 28,900 kw. roughly 24,000 kw. are available for consumption at 1600 sub-stations on the system.

The Capital Costs

The total cost of the system is given as Rs. 348 lakhs inclusive of all overhead charges. Out of this 127 lakhs have been spent for generation, 160 lakhs on transmission lines alone and 61 lakhs for transformers and switch gears, etc. The capital cost, therefore, comes to Rs. 1,204 per kilowatt installed. For the sake of comparison I give below the capital cost of other hydroelectric plants working in India.

		Rs.
Tata Power Co., Ltd. ..	..	550
The Andhra Valley Power Supply Co.	..	708
Tata Hydroelectric Power Supply Co.	..	566
The Cauvery scheme ..	..	550
The Mundi Hydro-electric Works	..	3,844

It is, therefore, evident that next to the Mundi scheme which holds the World's record in costliness, the present one has been the costliest. We, therefore, cannot congratulate the sponsors of the scheme on having achieved anything to *cheap* generation of electricity.

The cost of generation of the unit of energy is about 10·4 pies and the Irrigation Department expects that by 1940-41 this cost would come down to 8·95 pies (*i.e.*, ·74 annas). The cost of generation per unit in the case of other hydroelectric works is much less; in the case of the Cauvery scheme it is 3 pies (*i.e.*, $\frac{25}{100}$ annas).

Let us now turn to the rates charged by the grid supply. There are

(1) For Agricultural purposes.	1 anna per unit.
(2) All units in excess of 1200 per B.H.P. year	8 pies ($\frac{66}{100}$ anna) less 2 pies for payment within the scheduled time.

(3) For industrial use.	At 1 anna 6 pies per unit subject to the sliding scale of rates.
	For the first 1320 units -/1/6
	Up to 1200 units after the 1320 units -/0/9
	Next 900 -/0/7
	Remainder -/0/2½.
(4) For domestic use.	At 6 annas per unit with a discount of 6 ps. per unit for payment within 21 days of presenting the bill.

It may be mentioned here that the rate at which water is supplied to the cultivators is even higher than the existing canal rates.

It is evident from what has been quoted above that the Ganges Canal hydroelectric scheme has been conceived on an extremely uneconomic basis. The high capital cost is partly due to the fact that the whole load has been distributed over a very large area (about 4,000 miles of transmission lines) and a disproportionately high cost has been incurred in distribution. The initial objects that have led to the construction of such a long transmission system have been

(1) to electrify 88 towns most of which have a population of less than 20,000,

(2) to supply power for pumping water for canal irrigation in the case of Ramganga and Kali Naddi Rivers,

(3) to work the tube-well irrigation scheme, and

(4) to exercise agricultural machinery on private farms.

The load distribution as been done as follows:—

Industrial	10,500 kw.
Agricultural	3400 „
State Tube-Wells	10,970 „
Domestic	2,900 „

Much has been made of supply of electricity for agricultural power, for raising water from wells. It is well known that the agricultural load is required spasmodically for only a few months in the year. This has, therefore, substantially reduced the yearly load factor with subsequent increase in the generation cost. The first principles of economics therefore tell us that electrical power is unsuitable for agricultural purposes. One can convince himself if one finds out what percentage of total power is used for agricultural purpose in any other country. In Russia it is less than 2%. In China where in certain places fields have to be irrigated from deep wells, as in Western U.P., pumps driven by oil engines and mounted on motor trucks are in use. If the Government is anxious to promote well-irrigation, it appears that the grid system would be terribly expensive for on the average only 100 watts are consumed per mile. The best solution appears to be motorized pumps, motive power being obtained from petrol or alcohol engines.

It has been calculated that even at the present load factor, the cost price per unit at the generating station is only three pies. I can, therefore, only conclude that the supply would have been cheaper if instead of trying to capture the public imagination by the idea of rural electrification, the sponsors of the grid system concentrated on the load in a small area round the generating station. It may be argued that the power which is generated is much larger than required for these regions but the map of U.P. clearly shows that practically all the generating stations have a moderately big city within ten miles from it, thus, for example, the station Bahadurabad is near Hardwar, Chitura and Salawa near Muzaffarnagar, Bhola near Meerut and Sumera near Aligarh. These cities alone can easily consume all the power if it is really supplied at a cheap rate. It has been argued that on account of the absence of any mineral area in the vicinity of the generating stations there was no possibility of any development near the generating station but chemical industries, and other industries which depend most on electrical power could flourish easily if power was available at a much cheaper rate.*

Let us now turn to the steam-driven plants in our province and to the possibility of a scheme of electrification by installation of stations run by long-haul coal. We have, at present, steam-driven generators in all the big and important towns of

* It is not quite true that there are no minerals in the region referred to. There are deposits of bauxite, and copper, and others, but probably their economic posibilities have not been explored—*Editor.*

the province. These stations are run by Electric Supply Companies which have got licences from the Government and have powers vested in them by the Electricity Supply Act of 1910. It is difficult to know the exact cost of generation from the supply companies, as most of them treat this as a business secret. We can, however, easily calculate the cost price of a unit of electricity from a station run by long-haul coal from the fields of Bihar or Bengal. The price per unit will depend upon (1) the capital costs including distribution, (2) the fuel cost, and (3) the load factor. I, therefore, proceed to examine the items separately.

The cost of merely installing a Kilowatt for a moderately sized station is about Rs 200/-. We can suppose on the average that Rs 250/- will be spent on distribution, *i.e.*, making a capital cost of Rs 450/- per kw. It is easy to get money at 4% interest and if we keep 5% for depreciation and 3% for maintenance and repairs, a sum of 12% per year is needed on the capital invested. A kilowatt installed produces 8760 units of energy per year but all of it can only be consumed in an ideal case. Generally only 40% is available. The overhead charges per unit therefore come to

$$(450\times12 \div 100)\times(100 \div 8760)\times(16\div40)$$
$$= 24 \div 100 \text{ annas}$$

(2) The cost of fuel depends upon the distance from the coal fields. As an upper limit for the most western districts we can take the price per ton to be Rs. 20/- for our province. Now, we know that only 1.5 lbs. of coal* are needed to produce 1 unit of electricity. The price of fuel per unit, therefore, comes to 21/100 annas, making a total cost of 45/100 annas per unit for the western districts. (For the eastern districts Benares for example, the cost cannot exceed $\frac{30}{100}$ annas). This price for western districts as evident is almost half the cost price per unit of the Hydro-electric Grid electricity.

* This is an average figure for Great Britain. Some of the most efficient steam plants consume even less than a pound of coal for generating one unit.

The present situation of the supply of electricity energy in one province is therefore wholly unsatisfactory. There is one more project known as the 'Eastern grid and pumping project' which is under the examination of the Government. In this scheme the object of the government is to generate 7700 kw. from a fall of River Tons near Rewa (state), and to supply it for pumping water to irrigate some parts of the districts of Allahabad, Mirzapur, Partabgarh and Benares. The price as estimated is Rs. 880/- per kilowatt which is rather large and it is doubtful if the estimate would remain even this after the completion of the scheme.

In view, therefore, of the present unsatisfactory condition of the supply of power I venture to make the following suggestions:—

(1) That a power research board be appointed in this province to study in detail about the question of power generation and supply in this province and to formulate measures by which the generation of electricity may be done by the state on the lines of Soviet Russia and Great Britain.

(2) The Government should also investigate into the methods by which proper co-ordination between industry and electrification be established. No scheme of electrification can function well without proper co-ordination with industries.

(3) In order to encourge the development of rationalized cottage industries the government should establish model industries in important places in the electrified area, and should offer co-operation and advice to anybody who wants to run a cottage industry.

(4) Before launching any scheme the government should see that the proper material and technical staff is readily available in the country. If proper persons are not available batches of young men should be sent to foreign countries to learn the technique of electricity generation and distribution.

Technical Assistance to Indian Industry by the Government of India

THE question of technical aid to Indian industries by the Government has been before the latter and the public ever since the later half of the last century. After the disastrous famine of 1877-78 the Government of India appointed a Famine Commission to enquire into the causes and consequences of famines. Amongst their principal recommendations may be mentioned the following:

(1) In treating of the improvement of agriculture....the more scientific methods of Europe may be brought into practical operation in India by the help of specially trained experts, and the same general system may be applied with success both to the actual operations of agriculture and to the preparation of the market of the raw agricultural staples of the country. There does not appear any reason why action of this sort should stop at agricultural produce and should not be extended to the manufactures which India now produces on a small scale or in a crude form, and which with some improvement might be expected to find enlarged sales, or could take the place of similar articles now imported from foreign countries.

(2) The Government might further often afford valuable and legitimate assistance to private persons desiring to embark in a new local industry, or to develop or improve one already existing, by obtaining needful information from other countries or skilled workmen or supervision and at the outset supplying such aid at the public cost.

Unwillingness of the Government of India to promote Industrialisation

The report of the Famine Commission was published in 1880 and it clearly recognized that the poverty problem in India could not be solved by improvements in agriculture alone, but by a simultaneous improvement of the industries, which was equally necessary. In spite of the report and popular clamour, little heed has been so far paid to its most important recommendations. The Indian National Congress came into existence in 1885 and since its third session it has been off and on urging the Government for spread of technical education and encouragement of Indian industries. Since 1905, an Indian Industrial Conference had met for a number of years as an adjunct to the Indian National Congress and has repeatedly urged for measures for the encouragement of indigenous industries. But neither have the recommendations of the Indian Famine Commission nor the representations of the Indian National Congress nor those of the Indian Industrial Conferences produced any appreciable effect on the policy of the Government of India.

Lessons of the Great War

The outbreak of the Great War in 1914 drew forcible attention to the extent of India's dependence upon countries outside the British Empire for the supply of the many of the necessities of life for her people. It may be recalled that during the War, supplies of dyes, important chemicals, many important medicines were almost completely stopped and prices of textiles soared so high that poor people had to fall back upon old rags. The transport service was completely disorganized as almost all railway materials had to be imported from foreign countries, mainly England. The Government of

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India felt the necessity for a change in its industrial policy. In 1915, under the stress of war, the Government of India addressed the Secretary of State as follows:

> "After the War, India will consider herself entitled to demand the utmost help which her Government can afford to enable her to take her place, so far as circumstances permit, a manufacturing country."

This policy was nominally accepted by the Secretary of State for India and the Indian Industrial Commission, under the chairmanship of Sir Thomas Holland, was appointed in 1916 to consider and report in what ways this help can be given. The Commission formulated a comprehensive scheme for State co operation in industrial advance. A subsidiary committee to the Commision was formed under the chairmanship of Prof. Thorpe of the Imperial College of Science, London, to consider the technical work for the scheme of state co-operation formulated by the Industrial Commission. The establishment of an All-India Chemical Service was recommended to exploit the chemical resources of India. The public grew suspicious that the department would be completely dominated by service rules, and non-Indian experts. Sir P. C. Ray, who was a member of Thorpe Committee, wrote a strong note of dissent against the institution of a Chemical Service not based on professional efficiency and in his presidential address to the Indian Science Congress held at Nagpur in 1918, strongly pleaded for the Indianization of Indian scientific services. Public conscience was roused, and nothing further was heard about the institution of a Chemical Service.

A Mountain in Labour

The net result of the negotiations between the Secretary of State and the Government of India and of the labours of the Industrial Commission was the birth of another bureaucratic department that of the Imperial Department of Industries– a veritable mountain in labour. This Department apparently considered its task finished after it had organized a Stores Purchase Department. As far as we are aware, the departments of Industries have done nothing to promote any of the ***major industries of India.*** All this has been characteristic of a Government by civilians, which takes its orders from a Government 6,000 miles away, and is not responsible to the people for its actions.

How the Lessons of War were forgotten

The Industries Conference at which the centre and provinces took counsel ended with the fourth conference in 1922; the two held after the introduction of Montague-Chelmsford reforms had shown clearly that the provinces, arguing as Pandit Madan Mohan Malaviya did in his note of dissent to the report of Industrial Commission and as Sir P. C. Ray had also said, did not desire to see the establishment of any central scientific services. The Department of Industries of the Government of India was replaced by a ***Department of Industries and Labour,*** which had an even smaller share in the industrial policy than its predecessor. No action whatsoever was taken to give effect to the recommendations of the Industrial Commission which aimed at producing technical improvement of industries and their assistance in other ways. By 1923 the lessons of the Great War had been completely forgotten.

The Industrial Research Bureau

As a result of the Imperial Conference in 1926, the subject of Industrial Research came once more to the forefront and representation was made in 1928 to the Government of India by the provincial governments about the necessity of co ordination of industrial research work in India *and of the establishment of an Imperial Council of Industrial and Scientific Research on the lines of Imperial Council of Agricultural Research. The central government, however, shelved the matter on the ground of financial stringency.* At the fifth Industries Conference held in 1933, after a lapse of eleven years, it was agreed unanimously that a central co-ordinating authority should be set up for the co-ordination of industrial research, and, in 1934, the Government of India, being no longer able to avoid the question, set up an Industrial Research Bureau, attached to the Indian Stores Department with an Advisory Council, composed of representatives of the central and provincial governments with

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a few non-official members. A research branch was created at Government Test House, Alipore, Calcutta, to do research work on problems recommended by the Advisory Council.

Needs of the Country

National research requires national planning. If research is to be directed along the most useful lines, it is just as important for a nation as for a private firm to decide what it wishes to make and place on the market. It is clear also that any system of organized research must take into consideration the economic structure of the country. Indian industries are now and will be in future, chiefly based on the raw materials available in the country, but much still requires to be done for their development. The most prominent deficiency and most promising field is in connection with research work on the raw materials which are vegetable products. In the case of minerals good work has been done by the Geological Survey of India and our information regarding the mineral resources of the country has reached a relatively satisfactory stage. In the case of vegetable products, however, which occur in enormous quantities and in great variety, comparatively little work has been done of the kind necessary to translate the purely scientific (which, too, is extremely meagre) into a form suitable for the investing industrialist. It has to be ensured that the samples examined are representative, they must represent the plant at its best, the material must occur in quantities that would permit of economic assembly at a suitable place of manufacture and the accessory conditions ought to be such as to justify capital outlay. It has to be recorded to our shame that no such systematic work has been hitherto done, and the examination of little data that does exist concerning any product of probable commercial value generally brings into noticeable relief our ignorance of the very facts that are necessary for satisfactory industrial enterprise. Hardly any serious attempt was done to push the utilization of raw materials. For most industries, it is not the chief raw material that gives the wise investor anxiety as the accessories. The expert prospector of one substance may find his favourable results of no use without favourable results of a wholly different class. For, general industrial progress the manufactures of India must be in a position to make use of the results of work done elsewhere, but to apply them to local conditions is seldom easy. In some instances, the information available is designedly left incomplete and gaps have to be filled in by trials and experiments whilst the adaptation of methods and processes to Indian conditions and to Indian materials often involve in research work of a complex and difficult character. Between the first stage of the inception of an industrial undertaking and its actual realization there is usually a necessity for scientific and expert control. As the Industrial Commission observes,

> "Much money in the past would have been saved if the impotance of these preliminary investigations had been realized. Ordinarily, no firm can afford to risk the cost of employing the various experts so required in an uncertain venture. This is more appropriately the business of the State and the survey of its natural resources should be undertaken systematically, not in the form of an isolated series of special prospecting tests, which results in frequent repetitions, with wasteful overlapping of results and embarassing gaps."

Need for Power Survey and Research Institute

A special survey of the coal situation in India should be undertaken with a view to introducing economy in the methods of mining and consumption. Such a review of the fuel situation should include an examination of the measures in progress for rendering more accessible the undeveloped fields. The advantages in using wood fuel after conversion into gas should be investigated, particularly those in employing charcoal for the production of gas after the removal of the by-products which are of value for industrial purposes. France, which has no liquid fuel, but plenty of wood, has worked out a method of converting wood to liquid fuel and has shown that it is economic. Possible sources of industrial alcohol should be investigated. A liberal policy should be followed by the excise authorities when commercial requirements conflict with excise regulations. The utilization of water power is of the highest importance in view of the necessity of creating electrochemical and thermoelectric industries and of economizing the use of coal. An organization

should at once be created to carry out a systematic survey of the hydro-electric possibilities.

New Industries

At present there are many industrial enterprizes which can be started by the importation of machinery and experts provided sufficient protection is given against foreign competition. A recent illustration is offered by the sugar industry. Here we have mostly to imitate and not much to initiate. It was the adoption of such a course that enabled Germany, Japan and United States of America to achieve rapid industrial development. On the whole the best way for starting selected industries in India and for training the future managers is, after the fashion of Germany, Japan, Russia and other countries, for the promoters to draw liberally on Great Britain, etc., for real experts; then to select young men, already trained in technological institutions or working in similar industries, who have shown an aptitude to grasp new methods, and to put them through close disciplined industrial and business training under these experts and in industries of the foreign countries. It should be made a condition with the foreign industries supplying stores to India that they will have to afford facilities to Indians for such a training. Further, no foreigner should be imported into India unless he is a recognized expert in his particular line. He, too, should be engaged on a short-time contract and made to understand that he is being engaged and paid to teach our local men just as much as to introduce and carry on his work. The young man from abroad who is educated but inexperienced should not be brought to India and allowed to get his practice here. We shall later on refer to the machinery needed to achieve these objects.

Organization of Technological Institutes

The necessity of having good technological institutions for the training of workers for the factories and for producing future leaders of the industries has been thoroughly made out by the Industrial Commission. Its importance is realized by the Government. Several technological institutes, which have been established in this country, have, however, not lived up to the hopes they created. The reason for this failure has been two-fold. Firstly, there has not been any definite policy in their working. They have been controlled by civilian administrators and very often the scientific officers of the institutes themselves have been absolutely out of touch with real industrialists and scientists. Such a condition is conducive to vegetation. Secondly, proper care has not been exercised in selecting the right type of men to be in charge of them, although there had never been a dearth of such people in this country. The quality of students entering them was also not good as there were hardly any prospects for them after having received their training. Technological institutes and industries are complementary phases, one stands and works for the other. In the absence of any serious efforts to create and expand Indian industries, the products of technological institutes have to rust in enforced idleness as there are no employments for them. If these institutes are really to be of any use it is necessary that they should be properly staffed and properly supervised and efforts be made to attract good students whose services should be utilized after training.

Need for Industrial Museums and Demonstration Farms

A good deal of attention has been given to the Government demonstrational factories by the Industrial Commission. Their need seems to be felt in the case of cottage industries. Such factories as those of sugar do not serve any purpose. The one defect with them was that the officials in charge did not exert themselves in attracting industrialits and businessmen and the public in general to inspect them and be thereby benefited.

Need for Industrial Research

It is impossible to solve the problems of poverty and unemployment in this country and to lay the foundations of healthier cultural life without a large-scale industrialization of the country. At present all the civilized countries have developed their industries to such an extent that in order to compete with them in her own markets India must make the best use of her resources and her industries should be most efficient. It is science that will help her to

do this. This is in a sense a scientific age where there is an ever increasing recognition throughout the world of the importance of science to national development. A number of great nations are now expending large sums of money in financing scientific and industrial research with a view to using their natural resources to the best of advantages. Much attention is also paid to the improvement of industrial processes and also to conducting researches in pure science which it is hoped may ultimately lead to the rise of new industries. The need for such research is all the more important in the case of India, a country where it has been persistently neglected.

The cost of supporting research cannot indeed be justified by comparing it with the prime cost of production, especially when demands are falling off, but by the consideration that it is the means of improving and cheapening production and, in consequence, of increasing the demand. Research is a cost in the same category as insurance. It is an insurance against the effects of ignorance with the certainty, if it is wisely undertaken, of large and continuous bonuses.

What is Industrial Research?

To understand the nature of research work needed for the industrial uplift of this country, and to infer from that the kind of worker needed by us, we cannot but quote from the report of the Committee of the Privy Council for Scientific and Industrial Research, England (1921-22, pp. 30, 31).

" We have laid some stress on the importance of fundamental research as compared with the work directed to the removal of immediate and practical difficulties. There is indeed little basic difference between the fundamental research work required by industry and academic scientific research sometimes styled 'Pure research.' Real difference is of stimulus. The general tendency in pure research is to follow the train of thought of greatest scientific interest by pursuing the problem initially selected through all the ramifications which may present themselves or at least through all those which interest the investigator. The phenomenon investigated and the taste of the research worker are in most cases the only directive forces. In industrial research, on the other hand, the aim is more definitely objective; the work has a distinct purpose in view which the investigator must constantly bear in mind. He cannot afford to follow attractive bypaths unless he believes that they will lead him to a relevant destination. The problems of industry draw attention to gaps in scientific knowledge which it is essentially the duty of the industrial researcher to fill. The acquisition of such knowledge may be called fundamental research as applied to industry."

" We have been led to make these observations because we have found some evidence recently, of a good deal of misconception in the distinction popularly drawn between industrial and pure research. There is undoubtedly some ground for this attitude in the loose use by industrialists and company promoters of the word research to describe experiment by trial and error and in the attempts often made to solve complex problems connected with industry on the full scale without any adequate preparations for the passage from the laboratory to the works. The wise manufacturer knows better than this and the man of science supports him. But we maintain that the distinction between fundamental industrial research and pure research lies primarily in the source from which the impulse to its conduct is derived. We desire rather to emphasize the essential unity of all research; its stimulus may come from different sources; its application may be various, but its outlook, its spirit, its methods are one."

What makes a real Research Worker?

From the above we can infer the type of research worker we need. To borrow the words of the Late Lord Rutherford, the President of the Advisory Council of the Department of Scientific and Industrial Research (*Pres. Add. Ind. Sc. Cong. 1938.*)

" It is to be anticipated that the staff required for the scientific services in India and for industrial research will more and more be drawn from students trained in the Indian Universities. It is thus imperative that the Universities should be in a position not only to give a sound theoretical and practical instruction in the various branches of science, but what is more difficult, to select from the main body of scientific students those who are to be trained in the methods of research. It is from this relatively small group that we may expect to obtain future leaders of research both for the universities and for general research organizations. This is a case where quality is more important than quantity, for experience has shown that the progress of science depends in no small degree on the emergence of men of outstanding originality of mind who are endowed with a natural capacity for scientific investigations and for stimulating and directing the work of others along fruitful lines. Leaders of this

type are rare but are essential for the success of any research organization. With inefficient leadership, it is as fatally easy to waste money in research as in other branches of human activity."

What makes a Director of Research?

As this is rather an important point we further quote from the report of the Committee of the Privy Council of the Department of Scientific and Industrial Research, England (p. 22, Report for 1922-23).

"The degree of success achieved and the rapidity with which an industry comes to look upon its research associations as a factor in its well-being, must, however, largely depend upon the choice of the right type of director to organize and supervise the fulfilment of research programme. Not only must he be of sufficiently high scientific attainments, but he needs to have the power of exposition."

In India, good directors are more often an exception rather than a rule, mostly because people come to occupy these positions from the rank of Government servants according to their seniority but irrespective of their actual qualifications. We can take as an instance the recently started Industrial Research Bureau in which the workers, who are unfortunately classified in junior grades are, we are given to understand, efficient and up to the mark but the choice of the Director and the high paid officers expected to guide the research work of the lower staff (who are as much qualified as their officers) leaves much to be desired. Same is the case with the Imperial Institute of Sugar Research, Cawnpore, where the Sugar Technologist to the Imperial Council of Agricultural Research has been appointed the Director a man who has never handled any research problem. The results of these institutions are too obvious to be dilated.

How to get such Workers?

The selection of such potential investigators and leaders is by no means an easy task; for success in examination in science is no certain criterion that the student is fitted for research career. A preliminary training in research methods is required to select those who possess the requisite qualifications for originality and aptitude for investigation. A system of grants-in-aid or scholarships to approved students may be required for such post-graduate training. In Great Britain the financial help given by the universities and other educational institutions for training in research is in many cases supplemented by maintenance grants to promising students awarded by the Department of Scientific and Industrial Research. This system has proved of much value both in developing the research of the universities and in providing a supply of competent men both for research in pure science and in industry.

Conditions under which Research Work can be done

Something must be said about the conditions under which research work can be done. The Industrial Commission recognized the importance of this point. It observed: (pp. 77--78)

"We have found scientific experts forming heterogenous groups, with no uniform conditions of service, with no definitely established policy or precise limits to their activities. The results are waste of money in duplicating the equipment, absence of combined efforts to form satisfactory reference libraries, overlapping of research work on some questions with consequent neglect of others, absence of authoritative check as to the value of the results, confusion among the general public and disconcerting variety of isolated or short-lived serial publications................They are in isolated posts, generally with no official prospects of promotion of a kind that would satisfy any scientific man of energy and ability......Many of the scientific specialists quickly reach their maximum salary and witnessing the gradual rise in pay and position of their contemporaries in other services, naturally grow discontented, and consequently become of reduced value to the country. In view of the fact that no quantitative standard can be established to gauge scientific research, no one can say what the country loses by discontent among its scientific staff."

In a similar strain the Committee of the Privy Council writes:

"Staff, however devoted, cannot be expected to give a single-minded attention to their work if they are anxious as to their future for reasons in no way connected with their efficiency."

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Emoluments of Workers

Appreciating these points the Industrial Commission recommended a scale of pay for the industrial researchers as Rs. 450-50-1500. This scale might be a little too liberal as pointed out by Pandit Malviya in his note of dissent, but, for example, the present scale of Rs. 150-10-300 given to the researchers of the Industrial Research Bureau is disgracefully low. The funny thing is that the above scale was accepted by the Government of India when attempting to organize the scientific services probably in the hope that most of the services will be manned by Europeans, when, however, they came to translate the scheme, as they did by creating the Industrial Research Bureau they adopted the above mentioned scale for the Indian workers. It may be recorded most emphatically here that no good work will be done by such a band of underpaid and dissatisfied workers, howsoever capable they may be. The proper procedure ought to have been to have cadres similar to those present at the National Physical Laboratory, England, where there are several grades of workers between the lowest and the highest (their salaries are in the ratio of 1: 5, unlike that of the Industrial Research Bureau here, where the ratio is about 1: 15) and the former can aspire and work for getting the latter.

Organization of Industrial Research Work in England

Coming now to the proper organization, it is to be borne in mind that the organization of research for industry and for general national purposes will, in essence be the same for all countries, though it may vary in detail. We notice that this organization not only in Great Britain but in its dominions as well, is national in scope. Early in war the British Government recognized just as the Indian Government did, that when peace would come, a more systematic application of science and research over a broader field was essential in the national interest, and, amid the distractions of war, set up the necessary machinery to accomplish this. In 1915 the Department of Scientific and Industrial Research was formed. Its formation marked the first comprehensive and organized measure taken in Great Britain to help industry through the application of science. A number of new research organizations were set up, controlled and financed by the Department to deal with the scientific aspects of the subjects of great importance to the common welfare of people but on which little, if any, organized research had been undertaken. This department took over the control and guidance of the other scientific departments of the government, *e.g.*, the Geological Survey and the National Physical Laboratory. It further made arrangements to promote the application of scientific knowledge to the problems of individual industries. Small factories, which form the majority in every country, are not in a position to maintain research laboratories on anything but a small and inefficient scale. To overcome this difficulty, the Department, in conjunction with industry instituted a number of co-operative research associations representing the greater part of the main industries of the country. Each of these research associations is autonomous and controlled by the representatives of the industry concerned and is financed by contributions from firms belonging to the association, assisted by grants from the Department.

How the Research Organization actually Runs?

This healthy and sound experiment in the co-operative organization of research has proved a great success. In this connection the late Lord Rutherford remarks thus:

"" I can speak with some knowledge of the marked progress made by these two types of research organizations, as I have been privileged as Chairman of the advisory Council of the Department of Scientific and Industrial Research for the past eight years, to come in a close contact with them. While much still remains to be accomplished there has been a great advance in recent years in the recognition of the value of research in increasing the efficiency of industry. If we are to hold our own in face of the ever increasing competition in the world to-day, it is essential that our industries should take full advantage of the resources which science places at their disposal."......

" In Great Britain, the responsibility for planning the programmes of research, even when the cost is borne directly by the government, rests with research councils and committees, who are not themselves state servants but distinguished representatives of pure Science and Industry."

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Working Details of the Research Organizations

We must, if we are to achieve anything, first adopt the constitution of the governing and advisory bodies of all these scientific activities of the State on the model of the Department of Scientific and Industrial Research in England or of *Direction des Recherches Scientifiques et Industrielles et des Invention* in France. In England there is an advisory council composed only of eminent scientists and industrialists which determines the scope of research work and distributes funds, to various activities, placed at its disposal by the government. Every single scientific activity has its own committee and sub-committees composed only of specialist scientists to direct work on it. The research laboratories are guided by directors who are eminent scientists and are manned by competent workers. Their salaries and future prospects are such that they are satisfied with the work in their hand. In addition to these there are various co-ordination committees composed, as ever, of only eminent scientists. Their function is to bring about the co-ordination of the various departments of the government and the research laboratories in the solution of problems which necessitate such an action. As an example we may mention co-ordination committees on physics, chemistry and engineering.

How to Achieve this in India?

In India it is necessary that all the various scientific activities going on in the country receiving financial assistance from the government be placed under the guidance of councils composed of eminent Indian Scientists and Industrialists. The following will give an idea of the various activities meant here:

(1) Geological Survey.
(2) Forest Research Institute.
(3) Research Laboratory Soft Coke Cess.
(4) Research Laboratory Indian Central Cotton Committee.
(5) Research Laboratory Indian Jute Committee.
(6) Industrial Research Bureau.
(7) Imperial Council of Agricultural Research.
(8) Indian Institute of Science.
(9) Research Laboratory of the Army Department.
(10) Lac Research Institute.

There might be several others of similar type.

In addition to carrying on national surveys of raw materials and carrying on industrial research, the advisory council should hold periodical conferences with the businessmen, capitalists, industrialists and economists on new industries to be started in India and if the conference comes to some decision about the starting of any new industry, steps should be taken to send a sufficient number of brilliant young Indians to foreign countries to learn the various technical processes of that particular industry and to arrange to start the industry only on their return from abroad.

In this connection it is worth while to quote the late Lord Rutherford (Presidential Address, *Ind. Sc. Cong. 1938*).

"It is to be hoped that if any comparable organization is developed in India, *there will be a proper representation of scientific men from the universities and corresponding institutions and also of the industries directly concerned.* It is of the highest importance that the detailed planning of research should be left entirely in the hands of those who have the requisite specialized knowledge of the problems which require attack. In the British organizations there is no political atmosphere, but, of course, the responsibility for allocating the necessary funds ultimately rests with the Government."

Advantage of such a Constitution

To quote the words of the Committee of the Privy Council about the advantage derived from this kind of constitution (pp. 16, 18, report for 1921—22):

"One purpose of the co-ordinating functions assigned to the department is to secure economy in expenditure and in the use of scientific workers available for research. This economy cannot be effected if the financial arrangements adopted are not such as to permit other departments of state to approach the research department when an unforeseen requirement arises; otherwise there would be a tendency for departments to conduct their own research work by means of organisations not necessarily the most appropriate for the purpose."

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"It is not merely by the conduct of research that the department is adding to the national wealth or saving the pocket of the tax-payer. Though its expert boards and committees, it is often able to prevent expenditure which scientific considerations show to be unnecessary......The existence of a body devoted to the conduct of scientific research in a field so broad as that committed to us must inevitably, if it is efficient, collect in course of time a mass of detailed information and experience, both of men and of procedures, which is of the greatest possible value, not only to other departments in the preparation of their plans, but to all other bodies interested in the prosecution of research in the development of industry."

Conclusion

In the end we can hope for a speedy fulfilment of the above, as did the authors of the report on Indian constitutional reforms 1918, because,

"On all grounds, a forward policy in industrial development is urgently called for, not merely to give India economic stability; but in order to satisfy the aspirations of her people who desire to see her stand before the world as a well-poised, up-to-date country; in order to provide an outlet for energies of her youngmen who are otherwise drawn exclusively to government service or a few overstocked professions; in order that money now lying unproductive may be applied to the benefit of the whole community; and in order that the too speculative and literary tendencies of Indian thought may be bent to more practical ends and the people may be better qualified to shoulder the new responsibilities which the new constitution will lay upon them.

These are political considerations peculiar to India itself. But both on economic and military grounds imperial interests also demand that the natural resources of India should henceforth be better utilized. We cannot measure the access of strength which an industrialised India will bring to the power of the Empire; but we are sure that it will be welcome after the war."

Industrial Inefficiency of India

Lest anybody be under the illusion which is very often produced by official propaganda, that India has made any substantial progress towards industrialisation let us quote from a very interesting book *Economic Development of India* (1936) by Dr Vera Anstey

'Here is a country of ancient civilization, with rich and varied resources, that has been in intimate contact with the most materially advanced countries of the West, but which is still essentially mediæval in outlook, and organization, and which is a byword throughout the world for the poverty of its people.'

Then she quotes Mr M. L. Darling:

'The most interesting thing about India is that her soil is rich and her people are poor' and asks herself:

'Can India be called "Mediæval" when it is organized under a modern form of constitutional Government, possesses a great system of mechanical transportation, a unique system of irrigation, no less than seventeen modern universities, and has several large scale industries producing with the most up-to-date machines that have yet been invented?'

As a quantitative measure of the poverty the following figures will suffice:

Consumption	England	Japan	India
(Electricity per head in kWH units), 1936 ..	450	340	8
Coals (in tons) ..	4.93	.7	.06
Iron (in tons) ..	.28	..	.007

Studies in Indian Snake Venoms

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Scientific Classification of Snakes

POISONOUS snakes are divided into two great families, the *Colubridae* and the *Viperidae*.

The *Colubridae* type resembles the harmless snakes and are therefore all the more dangerous. They are divided into two groups, *Opisthoglypha* and *Proteroglypha*.

The *Opisthoglypha* group includes three sub-families:

A. *Homalopsinae*.

B. *Dipsadomorphinae*.

C. *Elachistodontinae*.

All the *homalopsinae* are aquatic. They are met commonly in the Indian Ocean, starting from Bombay and especially in the Bay of Bengal.

The *Proteroglypha* group of the *Colubridae* family is of much greater importance, since all the snakes belonging to it are armed with powerful fangs. This group is composed of two subfamilies:

A. *Hydrophiinae* (Sea-Snakes).

B. *Elapinae* (Land Snakes).

The *Viperidae* family is divided into two subfamilies:

A. The *Viperinae*.

B. The *Crotalinae*.

The *Elapinae* sub-family belongs to the genera

(*a*) *Bungarus*.

(*b*) *Naja*.

The Asiatic *Viperinae* belong to the genera

(*a*) *Vipera*.

(*b*) *Pseudo Cerastes*.

(*c*) *Cerastes*.

(*d*) *Echis*.

Indigenous Classification

It will be interesting here to mention that there has arisen an indigenous system of classification of snakes due to the constant and minute observation of the snake-catchers who are also healers of snake-bite. They are known as mal badyias in Bengal. They divide the snakes into two groups:

(1) Poisonous.

(2) Non-poisonous.

The poisonous snakes are usually of four varieties:

(1) *Baraphani*,

(2) *Gokshura*,

(3) *Keuta*, and

(4) *Bora*,

and are known as *chou-sáp* (*chou*—four *sáp*—snake). The group *Baraphani* is composed of the following members:

(*a*) *Patraj*,

(*b*) *Dudhraj*,

(*c*) *Bankaraj*,

(*d*) *Shankarchur*, and

(*e*) *Manichur*.

The *Khoya Gokshura*, *Kali Gokshura* and *Padma Gokshura*, consititute the Gokshura group. Various kinds of *keuta* constitute the group of that name *Shamuk-bhanga Keuta* is notorious.

In the *Bora* group, *Chandra bora* is very dangerous. Though the snake called Kanada or Krait otherwise known as poisonous chitta is poisonous and especially dangerous. It is not included in the list by mal-badyias, probably because of its socially lesser position among the members of the serpent family. The Kraits may be found anywhere in Bengal, in the house, in your bed, in earthen pots,

in the fissures and cracks of walls and the folds of quilts. They fall from the ceiling when it is a thatched house.

However, the following are the poisonous snakes found in Bengal:

(1) The Cobra (*Naja Naja, Naja Tripudians*).

(2) Keuta.

(3) The Shankarchur or the Hamadryad (King Cobra).

(4) The Krait or Kanada (Bungarus Fasciatus).

(5) Chandra bora (Russell's Viper).

(6) Shakni (*Bungarus Caerulus*).

(7) Hafac (*Echis Carianatus*).

Collection of the Venom

Poisonous snakes possess special glands capable of secreting venom. The poison glands occupy an extensive intramuscular space behind the eyes, on each side of the upper jaw. They are oval in shape and may attain the size of a large almond as in the case of the *Naja Tripudians.*

At the moment the snake starts to bite, it opens its jaw directing its fangs forwards; then the muscles that come into action compress the glands on each side and cause the venom to be expelled in a sudden jet. In the case of certain species, the venom may be projected to a distance of more than a yard. Venom can be extracted from the poison glands of both the freshly killed and living snakes.

The Indigenous Method of Extraction

The head of the reptile is held by the left hand and an oyster-shell (used as a spoon in India) is forced into its mouth. The shell is covered with a palm leaf. The mouth of the poison sac is opened and the poison comes in continuous stream through the fangs. After a second or two, the stream is reduced to drops and at last the drops cease altogether; and this shows that the sacs have been exhausted.

It takes several seconds to empty the sacs. The spoon or the shell is then removed and found to contain about 1-4 drams of poison. If a drop of the poison is taken and rubbed on the skin, one will mistake it for soap. If the palm-leaf, which has been pierced through by the fangs is now examined two punctures will be found about a quarter to half an inch apart.

In modern practice for the collection of the venom, all that is required to be done is to take special precautions so that the animal cannot coil itself round any object near the operator. It is wise to begin by pinning down the head of the serpent by means of a stick and to seize it with a pair of long fenestrated tongs shaped like forceps. Sometimes, the serpents are chloroformed so that they can be easily handled.

Freshly collected venom is a syrupy liquid tinged slightly yellow. It is said that its taste is very bitter. It is entirely soluble in water. The density varies from 1.03 to 1.05. Tested with litmus, the solution is slightly acid (*p*H- 6.2). All kinds of venoms are not equally affected by heat. The venom of the *Colubridae* family can easily stand a temperature up to 86°C, whereas those of the *Viperidae* family lose their toxicity at 70°C.

When the venom has been collected, it must be quickly dried in a desiccator over $CaCl_2$ or H_2SO_4. The dried venom looks crystalline, but actually it is not so; the appearance is like that of dried gum-arabic or albumen. In this dry condition, placed in well-corked bottles, protected from damp air, it may be kept almost indefinitely without losing any of its original toxicity.

Minimum Lethal Doses (M.L.D)

It is very difficult to specify, within broad limits, the dose of venom which will prove fatal for an adult. The quantity of venom introduced by the bite of a venomous snake depends upon a number of factors and very fortunately, the quantity of venom poured, is not always sufficient to cause death. Thus, in Bengal, specially on the banks of the Padma in the rainy season, when snakes are most numerous and most dangerous, the mean mortality scarcely exceeds 35-40% of the individuals bitten.

By experimenting upon animals and commencing with known doses of venom, which has first been dried and then dissolved in physiological saline or

sterile distilled water, the minimum lethal dose has been determined.

The average M.L.D. for a pigeon of average weight 300 gms. is given below:

0.1 to 0.3 mg. -Cobra Venom (intramuscular).
0.01 to 0.02 mg. Russell's Viper (intravenous).
1.8 mg. —Krait (intramuscular).
0.025—0.05mg. —Echis Carianatus (intravenous).

In general, the M.L.D. is directly proportional to the weight of the animal.

M.L.D. of cobra venom for dog 0.8 mg. p. kg.
" " horse 0.05 mg. p. kg.

Assuming that man, in proportion to his weight, possesses a resistance intermediate between that of the dog and that of the horse, we may consider that the lethal dose for man of average weight 60 kg. is 6 mg. *i.e.*, the M.L.D. for man per kg. is 0.1 mg. It follows that 1 gm. of venom would kill 10,000 kilos of man or let us say 165 persons of average weight 60 kg.

Physiological Action

The physiological action in the case of severe cobra-bite is quite different from that in the case of Viper bite. Cobra venom contains two toxic substances Neurotoxin and haemolysin. The former is mainly responsible for the death of the victim. It paralyses the nervous tissues while haemolysin causes partial haemolysis of the r.b.c. The Cobra venom produces no local effect over the site of the bite. The bite is not very painful in this case. It is characterised by the numbness that supervenes in the bitten part, rapidly extending throughout the body and producing dizziness and fainting. The patient soon experiences a kind of lassitude and an irresistible desire for sleep; his legs get weaker and weaker and can hardly support him; the breath becomes difficult.

By degrees, the drowsiness and the difficulty of breathing become greater. The pulse which at first is more rapid, becomes slower and gradually weaker. The mouth contracts and there is profuse salivation. The tongue appears swollen, the eyelids remain drooping and after a few hiccoughs frequently accompanied by involuntary emissions of urine and faecal matter, the unfortunate victim falls into the most profound coma and finally dies. The pupils of the eyes react to luminous impressions up to the last moment and the heart continues to beat for some time (even two hours) after respiration has ceased. All this takes place from 2—6 hrs.

Haemorrhagin present in Russell's Viper venom produces extensive haemorrhage. The seat of the bite immediately becomes very painful and first red, then purple. The surrounding tissues are soon infiltrated with sanguinolent serosity. Sharp pains accompanied by attacks of cramp extend towards the base of the limb. The patient complains of intense thirst and extreme dryness of the throat and the mouth. These phenomena continue for a very long period, even for 24 hours.

Chemical Study of Snake Venoms

The elementary chemical analysis of Cobra venom gives the following results:

C—43.04%	H—7.00%
N—12.45%	S—2.50%

The venom extracted from the poison glands of snakes contain a number of substances of more or less uncertain chemical composition. They can, however, be broadly classified into proteins and non-proteins. The protein content of cobra venom is about 94% and constitutes the largest fraction of the dried venom; the toxins and the enzymes are always found associated with it.

Cobra venom contains (1) Neurotoxin, (2) Haemolysin and also (3) Enzymes.

It has been possible to separate the neurotoxin from the haemolysin and to purify them to such an extent that for the same nitrogen-content, the purified samples of neurotoxin and haemolysin are about 17 and 4 times more active respectively than the dried crude venom (Ghosh and De).

It has also been shown that Cobra venom and Russell's viper venom contain proteolytic enzymes, the optimum activity of which is in the region of pH 7- 0 with casein as substrate and at pH 8—8.2 when gelatin and egg-albumen are used. Further, it has been shown that these venoms can oxidize haemoglobin to methaemoglobin and can hydrolyse Witt's Peptone, the pH for the latter reaction being 8.2—8.4 (Ghosh and De).

Ganguly and Malkana have shown that lecithin and cholesterol are present in cobra venom. The protein fractions contain

Globulin	..	.. 20.31%
Albumen	..	.. 39.69%
Primary Proteose		.. 11.31%
Secondary Proteose		.. 16.81%

The toxicity is associated with the secondary proteoses.

The chemical analysis of Russell's viper venom shows that it contains C, H, N, S, O. No phosphorus is present and accordingly no such substance as lecithin is present. The protein-content of the dried venom is about 96% and the protein fractions contain

Globulin	..	.. 23.35%
Albumen	..	.. 22.12%
Secondary Proteoses		.. 50.52%

The neurotoxic, the coagulant and the haemorrhagic action of Russell's viper venom are attributed to the secondary proteoses (Ganguly and Malkana).

Therapeutic Uses of Snake Venom

Rusell's viper venom solution is extensively used for haemostatic purposes. Investigations are being carried out on the possibility of the use of cobra venom in cancer-treatment, but no definite conclusion has yet been arrived at as to its efficacy. Cobra venom in small doses is used to relieve neuralgic pain.

Treatment of Sanke-bite

In practice, the rational treatment of the bite of a venomous snake must be directed towards

(1) Preventing absorption of the venom.

(2) Neutralising, by injection of a sufficient quantity of Antivenomous serum the effects of the venom already absorbed.

In order to prevent the absorption of the venom introduced into the wound, the first precaution to be taken is to compress the bitten limb by means of a ligature of some kind. The ligature must be tightly twisted and by compressing the tissues around the bite, an attempt should be made to squeeze out the venom that may have been introduced into them. The ligature should not be applied for more than half an hour, otherwise, it would interfere with the circulation of blood to a dangerous degree and would certainly injure the vitality of the tissues. The wound should then be washed freely with a fresh 2% solution of hypochlorite of lime or with a 1 in 100 gold chloride solution. A KMnO solution (1%) may also be employed.

The next thing to be done is to apply the serum therapeutic treatment. This treatment is specific. Unless we know the kind of snake which has bitten, this treatment cannot be applied with any reasonable chance of success. Nowadays, polyvalent serum is available which can be applied generally. The serum should be injected intravenously. The volume of the serum necessary is atleast 40 c.c. for complete cure when the bite is not severe*

*Read at an ordinary meeting of the Calcutta University Chemical Club on 26-7-38.

Symposium on Weather Prediction

UNDER the auspices of the National Institute of Sciences of India, a Symposium on Weather Prediction was held in the Meteorological Office, Poona, on the 25th and 26th July, 1938. Various aspects of forecasting of weather were discussed at the symposium, attention being focussed mostly on the problems facing the Indian meteorologist and the proposed or attempted methods of solution. Thus, papers presented at the meeting concerned long-range forecasting for a whole season as developed in India, medium range forecasts for 10-day periods as developed by the German and Russian schools, short-range, *i.e.* day-to-day, forecasting in India; with special reference to the use of air-mass analysis in this task, the problem of forecasting Nor' westers, the use of upper-air data in weather forecasting, thermodynamic studies of the atmosphere with special reference to latent instability, rainfall in Northwest India associated with winter disturbances, weather forecasting for aviation and the application of kinematical methods to forecasting.

In his opening remarks, Prof. M. N. Saha, President of the Institute, said that "Symposium" meant drinking together and at Poona, the Head-quarters of the Meteorological Survey of India, they had assembled to drink from the cup of knowledge offered by the department. He referred to the importance attached to the art of weather prediction, or rather weather-making in early times, and said that amongst certain tribes, the man who could bring about rain successfully by his magic was promoted to kingship, and when he failed, as inevitably he must have done, he was sacrificed to appease the wrath of gods. In India, about 500 B.C., there were Brahmins who professed to be specialists in the art of rainmaking. In modern times, every civilized country has organized meteorological services to obtain the knowledge of secrets of weather by combined effort, and to forecast weather for the use of the public. The Indian Meteorological Department has been trying to forecast weather by the use of synoptic charts from the time of Blanford and Eliot, and after the War, Indian Meteorologists have made substantial contributions to Weather Physics. But up to this time, the problems have proved to be far too elusive, and the day seems to be far distant when meteorological conditions may be predicted with the same precision as the position of plants or other astronomical events. He hoped that the discussions presented to the symposium would lead to a better understanding of the problems.

Dr C. W. B. Normand welcomed the visitors to the symposium on behalf of the Meteorological Department and reviewed briefly the complexities of the problems which faced the meteorologist. At one time, it was sufficient for the forecaster to restrict his attention to rainfall alone. Now the conditions had altered largely; the meteorologist had not only to forecast for storms over the sea and land but had to warn the airman who wanted detailed forecasts of upper winds, of height of clouds, of fog, dust-storms, squalls, etc. A variety of requirements had thus to be satisfied and yet his decisions had to be made quickly. There was no time for lengthy calculation such as would be necessary if he desired to, and could write complex mathematical equations relating to the weather situation at any instant and solve them to obtain the picture at a future instant. The most hopeful method from the practical point of view appeared to be to focus attention on the identification of air masses, homogeneous within themselves, and to the effects which a mutual interaction between the several air masses would produce. India was the country in which most attention had been paid to the subject of seasonal forecasting and yet, the most that we could do to-day was to give a very general indication of total rainfall over large tracts of the country for a period of two to four months. Dr Normand concluded by giving a brief general survey of the different aspects of the problem which was to be dealt with in detail by the subsequent speakers.

SYMPOSIUM ON WEATHER PREDICTION

Story of Long Range Prediction in India

Dr S. R. Savur told the story of seasonal (or long period) forecasting in India. The first forecast of monsoon rain, mainly based on the data of snowfall on the Himalayas and the Sulaiman range during the preceding January to May, was issued by Blanford in 1886. Eliot who succeeded Blanford added other factors like the southeast trades at Mauritius, Zanzibar and Seychelles, data of south Australia and Cape Colony and "Nile Flood". But in his method which was mainly graphical there was much chance of individual bias. A great improvement in foreshadowing monsoon rainfall resulted when Sir Gilbert Walker introduced the more impersonal method of correlation coefficients in place of Eliot's graphical method. The first forecast using a regression equation was issued by him in 1909. In 1924 he worked out six formulae for forecasting rain in the Peninsula, Northeast India and Northwest India in which use was made of some 28 factors selected out of a large number after applying the statistical test, now named after him. Mr Field, the pioneer of upper air work in India, was responsible for suggesting a new factor of special interest, *viz.*, use of upper air data in seasonal forecasting; his factor is the upper winds of Agra, in autumn to foreshadow the winter rains in Northwest India. The re-examination of the data in recent years and the application of the Performance Test showed a diminution in the significance of some of the factors. Nevertheless, the total correlation coefficient is still found to be 0·63 for total monsoon rainfall of the Peninsula and 0·64 for that of Northwest India and 0.72 for the winter rains of Northwest India. The present forecasts issued at present are for (*i*) the winter rainfall during January to March in Northwest India, (*ii*) the monsoon rainfall during June to September in Northwest India and the Peninsula and (*iii*) the monsoon rainfall during August and September in the same two divisions. Efforts were being made to decrease the period of the forecasts and also the area which they covered. Dr Savur emphasized that methods of correlation were strictly applicable only when all the quantities correlated varied according to the normal law of distribution. To overcome the handicap introduced by non-normality of distribution found in practice, general methods were being developed but the work was still in its initial stages.

German Forecasts for 10-day Periods

Mr S. Basu gave an account of the technical preparation of the 10-day forecasts issued by the German Meteorological Service which, he said, rests on a combination of statistics and synoptics.

The first consists in the determination of the connection between the 'foreweather' and the 'postweather' in the chosen interval of time by computing correlations, the choice of the elements and the interpretation of results depending on the physical-meteorological view points. This statistical handling of 'weather history' makes up the principal part of the work.

The second part of the work consists in the individual study and analysis of the 'broad weather situation' of the 'forecast day'. With the help of 'multiple correlation tables' definite days are extracted from the history of the weather in which the development of the weather was similar to that of the forecast day. Any rhythms appearing in the march of meteorological elements up to the forecast day are also followed up and the possibility of an extrapolation is weighed.

For the synoptic analysis of the situation, pressures and temperatures of the free air up to 5 km. of the forecast day and the preceding day, based on observations of the weather aeroplanes, are examined. For the 24-hour changes at the ground level the control by the pressure at 5 km. has been found to be very complete and has been called 'steering' by the Frankfurt School. Four types of steering, *viz.*, Northerly, Easterly, Trough- and Double-Steering, are recognized by Baur. Since the pressure gradient in the lower stratosphere, the average gradient of temperature in the troposphere and the general flow have a marked correspondence with the steering, which persists for some days, Baur considers this as the basis of the 'broad weather situation' determining the outlook.

Forecasts for Periods by the Russian School

In the 'composite map method' of forecasts developed by Multanovsky and his collaborators the e-interval for the forecast is determined by the

period which marks the type of the synoptic process involved.

The method is founded upon the basic idea that the weather is 'made' in the north sub-polar regions instead of moving from west to east with the general circulation. Owing to lack of adequate data from sub-polar regions, an indirect approach was made to work out this hypothesis by analyzing trajectories of pressure maxima grouped according to their origin. Three groups of trajectories were obtained; *viz.*, the normal polar type, the ultra-polar type and the Azores normal type. The positions of the axes of these groups, some of which are characterized by great stability, over certain regions call for completely determined types of weather in corresponding regions.

'Composite maps' are prepared by entering the centres of areas of high and low pressures, crests of high pressure and secondary minima accompanying the movement of the maximum. With the aid of the axes one can determine the distribution of pressure fields on the composite map and, conversely, a change in the orientation of the process can be determined from the distribution of the pressure fields. A weather type can best be identified by a combined composite map which is illustrated with the corresponding distribution of temperature, precipitation and wind associated with a given process. The trajectory of the anticyclone allows a determination as a first approximation of the origin and extent of modification of the air-mass; the further details of the weather are obtained from the pressure distribution.

The 'natural synoptic period' characterizing the weather type during which the pressure centres continue to form definitely marked pressure fields and an 'operation' continues along any definite axis is generally of 10 to 12 days' duration. Hence two or three days after the beginning of the new period, as soon as the orientation of the process becomes apparent, it is possible to determine the weather for the next 7 to 10 days.

It was observed that during the course of a whole series of changes leading to any typical phenomenon, there usually occurs 30 to 35 days previously a sort of 'flaring up' of a new process, or 'a threat'. Within this time interval one can distinguish approximately 5 or more 'moments', the pressure distribution in which represent the 'phases' leading to a 'development' along an axis having a definite direction. On the average there are 4 to 5 phases to the period of 30 to 35 days, though a phase may range from 6 to 15 days. The introduction of phases, and threatening moments associated with them, has made it possible to enlarge the forecasts considerably and to widen their scope. The most pronounced indication appears on the 13th to 14th day after the appearance of a threatening nucleus; this day on which is also indicated the region where an event is to occur is called the 'Regional day'.

An extension of similar considerations as above has enabled Multanovsky to prepare composite maps for seasonal forecasting also. For this purpose the western half of Siberia, Europe and the neighbouring seas are divided into 40--80 districts; with data from these districts atlases of composite maps and maps of typical operational areas of pressure maxima have been prepared for comparison with maps for any individual season for which forecasts have to be issued.

Mr S. Basu thought that the German method may be given a trial in India. He thought that the Russian method did not apply to Indian conditions.

Regarding the way in which these predictions are worked out, he read the following opinion of Sir G. W. Walker.

"The actual preparation of a monsoon forecast in India is simplicity itself by comparison with this (Franz Baur's) method."

Judging from the performance of the method for a number of years, it appears to have achieved a high measure of success in Germany.

Dr S. N. Sen explained the methods adopted in daily forecasting practice for identification of air masses which, broadly speaking, fell into two classes, oceanic and continental but could be subdivided into several sub-classes. He illustrated by means of charts certain types of stationary fronts which often developed over the Indian area. He also showed how use was made of stream lines and convergence patterns of air currents aloft deduced

from pilot balloon data and cloud movements, along with a knowledge of upper air climatology for identification of air masses and day-to-day forecasting.

Dr S. K. Pramanik spoke on the application of air mass analysis to the problem of forecasting of Nor'westers in Bengal. He reviewed the work of the various meteorologists in India who have written about the mechanism of Nor'westers. He said that while some of the Nor'westers might be due to the action of cold fronts or undercutting by cold easterly Himalayan air, the majority of those which occurred in the afternoon depended upon some insolation effect. In the morning there was an inversion between ·5 and 1·5 Km. with moist air below and dry air above generally with latent instability. The effect of insolation was like heating unequally a slightly inclined liquid from below with the result that convection currents rose irregularly over the country. With the advance of day and greater heating these convection currents would go higher and higher and if the heating was sufficient they reached the boundary layer wiping off the inversion and causing great instability. Convection currents when they reached this layer would shoot up with great violence and the upper air would come down with a rush causing a Nor'wester. As a consequence of this the speaker thought that the occurrence or not as well as the intensity of Nor'westers would depend upon the height of inversion layer or depth of moist air and the amount of insolation and that it might be possible to forecast the occurrence of Nor'westers if the height of the inversion layer were known and one could estimate the maximum temperature in the afternoon. He also explained the lag, often noticed, between the time of occurrence of Nor'westers and that of maximum insolation. He then described the morning conditions which appeared to be necessary for the occurrence of Nor'westers in the afternoon, and he said that if these conditions occurred, Nor'westers were to be expected in Bengal.

Dr K. R. Ramanathan gave a brief review of the development of upper air work in India and explained how the data helped the issue of forecasts relating to conditions on the ground as well as in the upper air. The data provided the basic information regarding the climatology of the upper air and helped intensive studies of the structure of atmospheric disturbances. He gave a few instances of the use of these data in such studies. For instance, he showed how warm fronts somewhat similar to those in European latitudes were found to be associated with storms and depressions in the Bay of Bengal. The two air masses between which the front formed were the dry cold air from northern India and the moist equatorial air from the south Bay. A modified type of front was associated with the storms of the premonsoon season. In monsoon depressions the main front formed between fresh monsoon air and old monsoon air, the former behaving as a cold mass and the latter as a warm mass. Dr Ramanathan also showed a picture of the general circulation of the atmosphere over India as obtained from pilot baloon ascents made for the past few years in this country.

The role of latent instability in the atmosphere formed the subject of an interesting communication by Dr N. K. Sur; in the absence of the author the paper was presented by Dr R. Ananthakrishnan. The term 'latent instability' which was defined by Normand in 1931 referred to a thermodynamic state of the atmosphere in which, under suitable circumstances, the initial expenditure of a small amount of energy led to the release of a much larger amount of energy. Absence of latent instability was ordinarily associated with dry fine weather with occasionally high clouds of the non-convectional type, while its existence was associated with convective clouds or instability phenomena like dust or thunderstorms. Interesting series of soundings taken during the formation of storms in the Bay of Bengal and their movement showed the progressive building up of latent instability conditions as a disturbance approached the station and its disappearance as it moved away or dissipated.

Mr S. P. Venkiteshwaran read an interesting paper on rainfall due to winter disturbances and the associated upper air temperatures over Agra.

Dr S. K. Pramanik gave an account of the kind of upper air data available in India. Of these only upper wind data including directions of cloud movements, apart from aeroplane temperature data from a few stations in Northwest India, are received in time for and are actually used for day-to-day forecasting in India. He explained the limitations as regards the availability of and the kind of

information available from upper wind data. He was of opinion that the upper wind data had been of great help in day-to day forecasting in India. He showed some sets of charts illustrating the help of upper wind in daily forecasting. They indicated occurrence of heavy rainfall with convergence of upper winds, decrease of rainfall with divergence of upper winds and stoppage of the supply of moist air currents, heavy rainfall in hills when moist air currents struck them and non-occurrence of Nor'-westers when surface conditions were favourable but upper wind conditions were not so.

Mr P. R. Krishna Rao discussed the problems which demanded attention in weather forecasting for aviators which could be divided into three categories - (i) regional, (ii) route, and (iii) local. In regard to local forecasting he explained the use being made at Karachi of tephigrams of aeroplane ascents in forecasting local convectional phenomena and formation, persistence or clearing of clouds. The soundings by aeroplanes had afforded a valuable aid in this task. He also referred to the question of fog forecasting and remarked how the Taylor Diagram had not proved very successful except in ruling out days when fog was unlikely.

The use of kinematical methods in weather forecasting as developed by Dedebant and Pettersen was explained by Dr S. K. Banerji. Whenever any pressure system, such as a cyclone, an anticyclone, a trough or a front was in continuous motion one could, from a knowledge of the changes in the 2 to 3 hour period preceding, calculate the velocity and acceleration of each point of the system and foretell the position and configuration of the system during the next 6 to 12 hours. The deepening or filling up of pressure over an area bounded by two closed isobars was equal to the planimetric value of the barometric tendency within the same area. Dr Banerji illustrated an application of these and other kinematical laws to certain Indian storms, particularly to explain the curvature of the tracks of the storms.

Lively discussion took place at the end of each of the papers mentioned above.

Dr Normand who wound up the discussion referred to the future of weather forecasting. He felt doubtful whether any statistical methods applied to surface data alone would result in much further advance in seasonal forecasting. Here as well as in other branches of forecasting we had to look to the upper air for further improvements in our forecasting capacity. There lay our hope. More data of soundings of the atmosphere by aeroplanes, radio-sounds or balloon meteorographs were needed for day-to-day analysis of the conditions in the upper air which alone would help us to understand the mechanism that was behind the making of weather. As regards the German method of forecasting for 10 days, he admitted that the method was worth giving a trial, but he must ask Mr Basu to give him an estimate before the work could be undertaken.

The President, in concluding, remarked that after listening to the debates, it appeared that the problem of weather prediction, except for the short range one, appeared to be more elusive than he had thought earlier. The success of Franz Baur's method appeared to be striking, but no physical arguments have yet been given as to why the weather at the height of 5 Kms. should control that on the surface for the next 10 days. He thought that the department may give a trial to the method over a meteorologically homogeneous area, say the Panjab, for a limited period of time. He agreed with Dr Normand that a large scale survey of the upper atmosphere by means of radio-meteorographs and aeroplanes should be undertaken, and expressed the hope that in view of the importance of weather prediction to all classes of people, the Government of India should be liberal in financing such schemes. The successful advance in this direction appeared to lie in a harmonious combination of survey, analysis of data, and application of principles of mathematics and physics, and he was glad to find that the composition of the department was ideal from that point of view.

General Presidential Address

British Association for the Advancement of Science, 1938.

THE address begins with the statement of the conflict that from a stand point of general and philosophical interest the results of modern science give one the impression that what the senses tell us about the external world is shown to be altogether misleading. The President, however, points out that on the whole the tendency of progress is to bring the more remote conclusions within the province of direct observation, even when at first sight they appeared to be hopelessly beyond it. He, then, refers to the conception of atoms, to the process of radioactive decomposition and to the ordinary matter not being really space-filling and says that though these and many other points of view have seemed at first sight to contradict the direct indication of our senses, they are not really so, because they are obtained and could only be obtained by sense indications rightly interpreted. The reason for this is that our senses have not primarily been developed for purposes of research, and we have in large measure to adopt them to that purpose by the use of artificial auxiliaries. The result of doing so is often to reveal a world, which to the unaided senses seems paradoxical. Thus the main subject of the address is chosen to be a survey of the ways in which such adaptations have been made, the particular sense selected for the survey being the human eye.

The mechanism of the eye consists mainly in its lens system for focussing the image, in its retina for receiving the image and in its rods and cones the light sensitive elements that distinguish colour. The qualities derived from such a mechanism are ideal for what we believe to be nature's primary purpose—that is for finding subsistence under primitive conditions and for fighting the battle of life against natural enemies. But for purposes of research we can increase the qualities by artificial additions over a wide range for examining the very distant or the very small, for increasing very largely the range of spectrum which can be utilised, and for enhancing the power of colour discrimination.

The invention of lenses led to that of telescopes and microscopes the solution of the problems of distant and small objects and is therefore one of the greatest scientific discoveries. Given perfect construction there is no limit in theory to what a telescope can do in revealing distant worlds. On the other hand there is a very definite limit to what a microscope used with, say, ordinary daylight can do, for the points on the object which are about half a wavelength apart cannot be distinctly separated, and this is the theoretical limit for a microscope using ordinary light. For this the ultraviolet microscopy is evolved and we are nearing the region of the spectrum where almost everything is opaque.

The lenses made of matter are useless for waves shorter than those used in ultra violet microscopic work. To avoid this we can make, for certain radiations, converging lenses out of empty space. According to our present views the cathode rays in one aspect consist of a stream of electrified particles; in another they consist of wave trains, the length being variable in inverse relation to the momentum of the particles. These cathode rays have the property of being bent by electric or magnetic forces and with the analogy of the bending of light rays in its property of refraction the so-called electrostatic or magnetic lens is constructed. The wavelength associated with an electron stream of moderate velocity is so small that if the electron microscope could be brought to the perfection of the optical microscope, it should be able to resolve the actual atomic structure of crystals.

Can artificial resources help to improve colour discrimination? There is the whole subject of spectroscopy that may be thought of coming under the head. A spectroscope has got its limitation in having a fine slit. But using a compromise width, M. B. Lyot working in the clear air of the Observatory of Pic du Midi has even been able to observe the solar prominences through a red filter which enables the whole circumference of the sun

to be examined at once without the limitations introduced by a slit. There is also the spectrohelioscope by Hale for the continuous watch for the bright eruptions of the red hydrogen lines.

Next comes the problem of retina. Certainly it cannot be supplemented. But artificial sensitive surfaces are substituted which are in some respects better than the one supplied by Nature. These are photographic or photoelectric surfaces sensitive to light. As is well known, the eye has maximum sensitivity to the yellow green of the spectrum. The sensitivity of the silver salts used in the manufacture of photographic retina is maximum in the blue violet and ranges on through ultra-violet to the X-ray region. The extension of the sensitiveness on the other side through green, yellow and red to infra red was not easy. However, success has been attained, largely by the efforts of Dr W. H. Mills and of Dr Mees of the Kodak Company, and we all see the fruits of it in the photographs by lamplight which are often reproduced in the newspapers. It is now known at what point water becomes opaque. The spectra of the major planets have been extended into the infra red, which supplied the clue as to the true origin of the mysterious absorption band due to their atmospheres which had baffled spectroscopists for more than a generation.

Another substitute for retina is the photoelectric surface. This is a clean surface of alkali metal *in vacuo* which responds to visible light and passes comparatively large currents. The credit is due to two German schoolmasters, J. Elster and H. Geitel. They could scarcely have foreseen that their work, carried out in purely academic spirit, would make possible the talking films which give pleasure to untold millions. The photoelectric cell is used like the photographic plate at the focus of an astronomical telescope. It has been applied with success to guiding a large telescope or, in a humbler sphere, to open doors or even to catch thieves. Another interesting application of the photoelectric cell is in the measuring of the diameters of nebulae. Stebbins and Wintford have found, by attaching a photo cell to their telescope, that the linear dimensions of the great Andromeda nebula is twice as great as had been concluded from visual photographs.

The photoelectric cell is also instrumental in the development of television. Here the photoelectric surface is divided into minute patches which are electrically insulated from one another, and unlike the natural eye which has probably half a million connections between the human retina and the brain it has got only one single connection which is in effect attached to each of the patches in rapid succession by the process of " scanning " the image. With such a photo-cell the transmutation of a momentary image into a series of electric pulses is very easily effected, and which are amplified and sent out as wireless signals to turn back again into visible picture at the other end. Dr V. K. Zworykin has suggested that this electric eye or iconoscope, as it has been called, can be used to make visible the image in the ultra-violet microscope. It may also be used for raipd photography if the photographic plate replaced the viewing screen. The beauty of the device is that the energy is supplied locally, the distant light source merely releasing it.

In winding up the subject the Rt. Hon'ble President emphasized that main triumphs of science lay in the tangible facts which it had revealed; and it was these which will without doubt endure as a permanent memorial to the present epoch. Thus the main thesis of the address had been that these were discovered by methods not essentially different from direct scrutiny.

The second part of the address is on " Science and Warfare." Science, it is urged, is the source of all the trouble, since the important weapons of modern warfare, the high explosives, the poison gas and the thermite incendiary bombs and the aircraft are all products of the effort belonging to men trained in science. Tracing the history of the discovery of each of them it has been shown that military objects were certainly not the incentive of the successful investigators, who proceed with the spirit of scientific curiosity and with no possibility of telling whether the issue of their work would prove them to be fiends, or dreamers or angels. For good or ill, the urge to explore the unknown is deep in the nature of mankind. The world is waiting in readiness to snatch away the results of this urge, and to use them for its own purposes.*

* An abstract of Lord Rayleigh's address.

Extension of the Periodic Table and the Elements beyond Uranium

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ON examining the Periodic Table we find that the number of naturally occurring elements from hydrogen to Uranium is 92. This has been confirmed by Moseley's researches on X-ray spectra and the determination of atomic number.

Of these 92 elements two remaining still undiscovered are the elements Nos. 85 (Eka-iodine– a homologue of iodine) and 87 (Eka-Caesium –a homologue of Caesium). Recently Horia Hulubei in France claims to have discovered the element No. 87 by means of curved crystal focussing spectrograph in the mineral Pollucite. To this the name Modavium has been given.

The Periodic Table is characterised by a number of well-defined periods based on the gradual filling up of successive quantum groups by electrons. Thus we have:

1st Period of two elements with 1st quantum group completely filled up;

2nd Period of eight elements with 2nd quantum group completely filled up;

3rd Period of eight elements with 3rd quantum group partially filled up;

4th Period (long) of eighteen elements with 3rd quantum group completely and the 4th quantum group partially filled up;

5th Period (long) of eighteen elements with both 4th and 5th quantum groups partially filled up;

6th Period (long) of 32 elements with 4th quantum group completely and both 5th and 6th quantum groups partially filled up;

7th Period (incomplete) of six elements only with new electrons added to the 6th and the 7th quantum groups.

This last or the 7th period has certain characteristics of its own and does not follow the developments of earlier periods. A group resembling the rare-earths between actinium and thorium is missing here—an interruption or break in the otherwise continuous thread. Actinium may be regarded as the sole representative here of the rare-earth elements of the preceding period.

All the elements of this period, as well as polonium and radon of the previous period, are unstable and naturally radio active. This period ends abruptly in the middle without arriving at a partial stability in an element of pseudo-inert gas structure like eka-platinum and a final stability in an element like eka-radon, as is the case with the foregoing periods. It is believed that with increasing atomic weights the atoms become more and more unstable and the existence of elements beyond uranium in nature becomes consequently an impossibility. Even if they would exist, they would have been too short-lived to be detected.

All the radio-elements, produced by the spontaneous disintegration of the heaviest elements Th and U, are found to be isotopic with one or other of the naturally occurring elements of the 6th or the 7th period.

Discovery of numerous isotopes of commoner elements by Aston and the artificial transmutation of elements by bombardment of the atomic nuclei with projectiles like α-particles, neutrons, fast protons and deuterons have added to the heterogeneity of our elements. The ultimate products of all artificial transmutation are stable nuclei identical with isotopes of commoner elements. There are very few stable elements now which have not yielded to this artificial disintegration and we are thus acquainted with numerous nuclear chemical reactions

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dealing with changes in the atomic nuclei. It should, however, be noted that one or other of the fundamental particles, already mentioned, always forms a reacting unit in these reactions.

Besides these we are now furnished with a number of new unstable isotopes of known elements as intermediate stages in many of these artificial transmutations. These break down with emission of positrons or electrons. The phenomenon goes by the name of induced radio activity.

Curie and Joliot prepared for the first time this type of artificial radio-active atoms by the irradiation of Al and B with α-particles.

$$^{27}_{13}Al + ^{4}_{2}He \rightarrow ^{30}_{15}P + ^{1}_{0}n$$
$$^{30}_{15}P \xrightarrow{3{\cdot}2\ \text{min.}} ^{30}_{14}Si + e^{+}.$$

$$^{10}_{5}B + ^{4}_{2}He \rightarrow ^{13}_{7}N + ^{1}_{0}n$$
$$^{13}_{7}N \xrightarrow{14\ \text{min.}} ^{13}_{6}C + e^{+}.$$

They succeeded in separating the radio phosphorus and radio nitrogen by chemical means from the mother substances and thus definitely established the mechanism of the reactions. In the first case aluminium after irradiation was treated with caustic soda; the liberated gas was found to be radio-active. In the second case, where boric acid was used as the target, the latter was heated in air; the evolved gases were treated with metallic calcium after purification by pyrogallol, calcium chloride, etc.; the activity was found with calcium. The latter, on treatment with water gave out ammonia which was found to be active.

This was soon followed by the discovery of many similar other processes by these and other investigators. Moreover, processes were found in which artificially active body emitted no positron but β-rays or electrons. In other words, it changes into an element of higher atomic number.

But this Curie Joliot process in which primarily an α-particle is captured and a neutron emitted, is effective only with lighter elements, *i.e.*, in cases where the repulsive force of the nucleus on the α-particle is not very great. The heaviest elements undergoing disruption by this process are potassium (19) and calcium (20). Similar results were obtained also by the use of artificially produced positive rays like fast protons and deuterons.

A great service has, however, been rendered to the development of nuclear chemistry by the Italian physicist Fermi and his co-workers by employing uncharged neutral particles neutrons in place of the charged ones for atomic disruption. In a very short time this new process has furnished us with radio active isotopes of almost all chemical elements up to uranium. No potential barrier exists for the entrance of the uncharged neutrons into the atomic nucleus.

Sources of neutron for the production of artificial radio-elements are furnished by a mixture of radium or radium emanation and finely powdered beryllium sealed into a glass tube. The neutrons arise by the reaction

$$^{9}_{4}Be + ^{4}_{2}He \rightarrow {}_{6}C^{12} + {}_{0}n^{1}.$$

They pass practically unchanged through the glass.

There are three types of nuclear reactions set up by the neutrons:

I. (*a*) $^{27}_{13}Al + ^{1}_{0}n \rightarrow ^{28}_{13}Al \xrightarrow{2{\cdot}3\ \text{min.}} ^{28}_{14}Si + \bar{e}$

(*b*) $^{27}_{13}Al + ^{1}_{0}n \rightarrow ^{27}_{12}Mg + ^{1}_{1}H$
$$^{27}_{12}Mg \xrightarrow{10\ \text{min.}} ^{27}_{13}Al + \bar{e}$$

(*c*) $^{27}_{13}Al + ^{1}_{0}n \rightarrow ^{24}_{11}Na + ^{4}_{2}He$
$$^{24}_{11}Na \xrightarrow{15\ \text{hours}} ^{24}_{12}Mg + \bar{e}$$

starting from the same element, three different elements are produced.

II. (*a*) $^{23}_{11}Na + ^{1}_{0}n \rightarrow ^{24}_{11}Na \xrightarrow{15\ \text{hours}} ^{24}_{12}Mg + \bar{e}$

(*b*) $^{24}_{12}Mg + ^{1}_{0}n \rightarrow ^{24}_{11}Na + ^{1}_{1}H$
$$^{24}_{11}Na \xrightarrow{15\ \text{hours}} ^{24}_{12}Mg + \bar{e}$$

(*c*) $^{27}_{13}Al + ^{1}_{0}n \rightarrow ^{24}_{11}Na + ^{4}_{2}He$
$$^{24}_{11}Na \xrightarrow{15\ \text{hours}} ^{24}_{12}Mg + \bar{e}$$

Same element results from three different sources.

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The unstable artificial radio-elements, thus produced, emit β-rays and change into the stable next higher element, whereas the artificial radio elements produced by positively charged proton, deuteron and α-particles generally emit positrons and change into the stable next lower element. The possibility of one or the other of the above three types of neuclear reactions being induced by neutrons deepnds on the velocity of bombarding neutrons and the nature of the irradiated element. Processes (*b*) and (*c*) are more frequent with fast or energetic neutrons and with relatively lighter elements; otherwise the corpuscular rays cannot leave the field of their mother atoms. The process (*a*) occurs only with slow neutrons in the case of lighter elements and with both fast and slow neutrons in the case of heavier elements, but even then much intensified by the slow neutrons. The slow neutrons can hang about the nucleus more easily than the fast ones.

A simple method of slowing down the neutrons consists, as shown by Fermi and his co-workers, in passing them through hydrogen containing substances like paraffin or water.

Most of the artificial radio-elements have very short life and hence readily break down into stable elements. There are, however, few whose lives extend over days, weeks and months. The amount of the active element, artificially generated, is always insignificantly small. They are, therefore, detected and identified mostly by their radioactive properties, *e.g.*, by β-ray electroscope, Wilson Chamber and most conveniently by Geiger-Müller Counter. In many cases the result has been confirmed by chemical separations followed by activity measurements.

The question then naturally arises—what is the practical significance of these artificial radio-elements and to what addition to our knowledge they may be expected to contribute? Leaving aside their great importance in the physical investigation of nuclear structure, to us, the chemists, they furnish extraordinariry sensitive tests for the detection of chemical elements. They may thus be used as radioactive indicators for the detection of almost all elements.

The limit of sensitivity of a micro-test lies at or about 10^{-8} gm. or 10^{-2} γ. 10^{-8} gm. Pb contains about 30 billion atoms. With radio-lead as an indicator lead can, however, be detected down to 10^{-17} gm. or even less; and with the help of physical methods, such as Wilson Chamber or Geiger-Müller Counter, detection can be made even of single atoms. These artificial radioelements, though generated in unweighable quantities, can be mixed with their inactive isotopes in any amount. The activity of the former can then be employed as an indicator for the latter. Like the natural radio-elements, these artificial radio-elements furnish us with a large store of materials for use in physical, analytical, preparative and geo chemistry. A special use of them is likely to be found in bio-chemistry and medicine; *e.g.*, in the investigation of the circulation of physiologically important elements in animal and plant lives, or of the accumulation in healthy or diseased organs of physiologically active heavier elements. Some work has already been carried out on these lines.

An instance of the use of artificial radio-elements in chemical examination may be described here. Radio gold ($T = 65$ hours) and radio-silver ($T = 22$ Sec., and 2.3 min.) have been prepared by neutron bombardment (slow neutrons). A gold-silver alloy, when irradiated for a short time with slow neutrons will show only the rapidly decaying activity of radio silver, by long irradiation the activity of both radio-silver and radio gold. In the latter case the silver activity practically disappears after 20 minutes, whereas that of gold will continue for days. Hence it is quite easy to detect any adulteration of silver in an object made of gold by short irradiation with neutron. The object suffers absolutely no damage by this process of examination.

In the above case there was no necessity of separating the active product from its inactive isotopes. But in many cases, specially in the medical investigation of animal and human bodies it becomes desirable to obtain the active radio element in as concentrated form as possible, almost in unweighable quantities free from other substances.

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For this purpose a large amount of the inactive substance is irradiated and from this the active isotope is separated almost in weightless amount by suitable chemical methods.

Szilard and Chalmers irradiated ethyl iodide by means of neutron after mixing it with a trace of free iodine. The free iodine was then reduced to hydriodic acid, the latter was precipitated by silver nitrate. The precipitate of silver iodide showed an activity 200 times greater than that of unconcentrated iodine.

The atomic weights of all these artificial radio-elements produced by neutron radiation are rather too high compared with their atomic number. Hence, they all emit β-rays and thereby increase their nuclear charge by one unit. The atom type, thus arising, is stable and does not change further. From radio-sodium arises the stable magnesium, from radio-magnesium the normal aluminium and so forth; from radio-gold arises the stable mercury and not otherwise, gold from mercury, as was previously believed.

But the matter becomes quite complicated when we arrive at the end of the Periodic Table; *i.e.*, when thorium or uranium are irradiated by neutrons. We are dealing here with already (naturally) active substances.

From thorium Meitner and Hahn have obtained isotopes of Th, Pa, Ra and Ac.

Still more complicated are the transformations with uranium. Fermi and his co-workers have shown that by irradiation of uranium by neutron four new radio-elements of half-life periods 10 Sec., 40 Sec., 13 min., and 100 min. are artificially produced. The latter two were chemically separated by them and believed to represent elements beyond uranium in the Periodic Table.

The subject has recently been fully investigated by Hahn and Meitner. As a result of their brilliant investigations they have been able to separate chemically the successive products resulting from uranium by irradiation with neutron.

The uranium was freed as far as possible from its natural disintegration product U by chemical separation before it was exposed to neutron. The irradiation was carried out for minutes, hours and days long, whereby short-lived and also comparatively more stable substances of longer life-period were obtained in increasing amounts. Chemical and electro-chemical separation of the products were made after the addition of different carrier substances, which led to a definite conclusion about the chemical nature of the active products. Measurement of activity was made by Geiger-Müller Counter.

From a study of the decay curve of the active products and by the various physical and chemical methods Hahn, Meitner and their co-workers have been able to establish the following three different transformation processes induced by neutron in uranium.

By slow neutrons.

I. $^{238}_{92}U + ^{1}_{0}n \longrightarrow ^{235}_{90}Th + ^{4}_{2}He$

$\xrightarrow{\beta} ^{235}_{91}Pa \xrightarrow{\beta} ^{235}_{92}U \xrightarrow[23\ \text{min.}]{\beta} ^{235}_{93}\text{Eka-Re.}$

By both fast and slow neutrons, but promoted by slow neutrons.

II. $^{238}_{92}U + ^{1}_{0}n \longrightarrow ^{239}_{92}U$

$\xrightarrow[10\ \text{sec.}]{\beta} ^{239}_{93}\text{Eka-Re} \xrightarrow[2\cdot2\ \text{min.}]{\beta} ^{239}_{94}\text{Eka-Os} \xrightarrow[59\ \text{min.}]{\beta} ^{239}_{95}\text{Eka-Ir}$

$\xrightarrow[66\ \text{hours}]{\beta} ^{239}_{96}\text{Eka-Pt} \xrightarrow[2\cdot5\ \text{hours}]{\beta} ^{239}_{97}\text{Eka-Au}$

By fast neutrons only.

III. $^{238}_{92}U + ^{1}_{0}n \longrightarrow ^{237}_{92}U + 2\,^{1}_{0}n$

$\xrightarrow[40\ \text{sec.}]{\beta} ^{237}_{93}\text{Eka-Re} \xrightarrow[16\ \text{min}]{\beta} ^{237}_{94}\text{Eka-Os} \xrightarrow[5\cdot7\ \text{hours}]{\beta} ^{237}_{95}\text{Eka-Ir.}$

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Since by successive β-ray changes the atomic number continually rises with atomic weight remaining constant, a reverse process may finally intervene in which with α-ray emission the atomic number will be reduced again. Such α-ray emitters will, as could be expected, be relatively longer-lived elements, the proof of whose formation can possibly be obtained by long irradiation with much more powerful sources of neutron than hitherto available.

The artificial production of elements Nos. 93, 94, 95, 96 and 97 shows that our Periodic Table can be extended not only to the Eka-Pt of pseudo-stable electronic structure resembling platinum but even beyond to Eka-Au. Its normal termination should, however, occur in another inert gas Eka-Radon, which would be a homologue of Radon. Whether any further extension will be possible or the process will be reversed with expulsion of α-particles, protons or positrons before we can arrive at Eka-radon, only future investigation can prove. We should now wind up with the happy feeling that man has been able to extend nature's creation in this process of building-up of elements.*

* From a lecture delivered before the Science Society of the Benares Hindu University—March, 1938.

Our Rebel Collection

To those of our readers who admit an interest in the odd and unusual, as exhibited in the workings of the human mind, we have often thought of revealing one aspect of an editor's duties for which no corresponding evidence appears in the published periodical. Arriving with the manuscripts that are considered seriously for publication are usually to be found a few which, could they but be published, might provide the readers - or at least those of them having curiosity about curiosa - almost as much return in entertainment, even if not of value, as the more dependable information regularly presented. These are the scientific hypotheses of the studiously unorthodox. All men of science frequently receive such hypotheses from those who are in rebellion against what they term "orthodox science," but the editors of journals of popularized science probably receive more than any scientist—unless it be Professor Einstein, who recently told us that one of his biggest problems was to sort his worthwhile mail from this kind of communications.

It seems to be almost nothing for a man without much scientific training to sit down and solve the subtlest secrets of the universe—the nature of matter and of life, for example—in a single session. Failing to obtain publishers after trying all magazines, they do their own publishing, and thus for many years we have been receiving curiosa, both pamphlets and books: "Newton's Law Disproved." "The Riddle of the Universe Solved." "Rex Rays—the Great Discovery." "Avity, the Secret of Gravity." These are but four—we could go on naming them to a pageful. But for a sense of detachment and perhaps of humor, these offerings, usually attacking prominent scientists with venom, might jaundice an editor's life. Instead, we collect them!

Years ago, when starting this collection, we wondered whether it would not pay science to deputize a scientist to examine them all, in hope of finding occasional pay-dirt. To-day we believe we were wrong. Instead, we hope to deposit them permanently in some university library of the history of science. Future historians might otherwise judge that, in our era, pseudo-science was already extinct.

—*Scientific American*

NOTES AND NEWS

New Museum at Nagarjunokonda

Nagarjunokonda in the Madras Presidency is a place of much archaeological importance, as revealed by the excavations carried out there by the Archaeological Survey of India. A number of monasteries, temples, stupas, inscriptions, coins and large collections of magnificent bar reliefs have been discovered there. The place bears the name of the great Buddhist savant who was among the earliest of the teachers of the Mahayana cult of Buddhism which is still in vogue in Tibet. The inscriptions found here show that its ancient name was Sri-Parbati, where Nagarjuna, according to Tibetan tradition, spent the latter part of his life, this leading to the complete identification of the place. Inscriptions belonging to the Great Stupa at Nagarjunokonda record that this monument had been consecrated by the deposit of a relic (*dhātu*) of Buddha himself. This relic was discovered in a tiny, round gold box, together with a few gold flowers, pearls, garnets and rock-crystal beads. It is now kept in the Mulagandhakuti-Vihara at Sarnath, near Benares. The Archaeological Survey of India has now brought out on this subject a memoir, titled *The Buddhist Antiquities of Nagarjunokonda,* in two parts, written by A. H. Longhurst, formerly Superientendent of the Archaeological Survey for the Southern Circle, and now Archaeological Commissioner in Ceylon and Dr S. Paranavitana of the Archaeological Survey of Ceylon. The book is properly illustrated, and describes in detail the finds at Nagarjunokonda.

The Government of India sanctioned a museum at this place for housing the remarkable series of reliefs found here, and the construction is nearing completion.

Tidal Predictions by Geodetic Survey

It is well known that the Survey of India have been bringing out a publication every year on the tide tables of the Indian Ocean. This publication is of great importance to those who navigate the seas. The predictions of the tides are made by the Geodetic Survey of India, with the help of a machine kept in the Survey office at Dehra Dun. It has an interesting history behind it. It was invented in 1872 by Lord Kelvin and first set up in the Indian Stores Department, Lamberth, and later on at the National Physical Laboratory, Teddington. In 1921 the machine was brought out to India, and ever since it has been there at Dehra Dun. It is used for the annual prediction of tides at 41 ports in the Indian Ocean three or four years in advance. The predictions are incorporated in the annual publication, as said above. It gives the times and heights of each high and low tide at 28 ports obtained from the other sources in addition to those for the 41 ports in the Indian Ocean predicted on the machine. What is done to get the predictions of tides at any port is first to record the height of the tide at any port throughout the 24 hours of the day for at least one year or preferably for several. This record is then mathematically analysed. Once the analysis of any port is completed, the machine is set in phase to run a tidal diagram enabling the tides at that port for any year to be predicted.

Haveli Irrigation Project

The Haveli irrigation scheme for which the Punjab Government recently raised a loan of Rs. 1,00,00,000, was originally estimated to cost Rs. 5,25,00,000. But the actual expenditure owing to several savings effected is likely to be much less.

The expenditure during 1937-38 was Rs. 64,50,000 out of which the Punjab Government met Rs. 45,00,000 from their own resources and the balance from the cash section of the loan raised last year. This year the expenditure is estimated to Rs. 1,50,00,000.

The Punjab Government are able to meet half a crore from their own resources and for the balance the loan was floated.

The project, when fully developed, will provide perennial irrigation to 500,000 acres and non-perennial irrigation to 450,000 acres in the Jhang, Multan and Muzaffargarh districts. The estimated net annual revenue ten years after the canals begin functioning and after paying working expenses is Rs. 43,00,000 which means a return of 8 per cent on the capital expenditure, but it will be more in view of the savings mentioned above.

The project, when completed, will add considerably to the prosperity of the province. The main canal is being lined with *pucca* masonry.

Progress on the construction of the Emerson Barrage, the headworks of the project, and other works has been remarkable. It is hoped to finish the work in about two years against an estimated period of five years.

Demand for Enquiry into the All-India Radio Rejected

In the Central Assembly a resolution was moved on August 10 last by Sardar Mangal Singh, which recommended the appointment of a committee with a non official majority to enquire into the working of the All-India Radio. The public, it is agreed, is not satisfied with its working, and it is for the authorities to allay their suspicions, whatever they be, and satisfy them on this score. Though the supporters of the resolution made it clear that the resolution was not necessarily meant as a censure, but urged that an enquiry would serve to assure public opinion that a new department as the All India Radio was proceeding along right lines of development. It was opposed vehemently by the Government and their supporters and rejected. In our view these would have been a distinct gain, had such an enquiry been allowed to be made, and the results published to satisfy the public.

Changes in Electric Rates in Bombay

Under the Bombay Finance (Amendment) Act, 1938, the duty on electricity used for the purpose of lights and fans has been increased from 6 pies to 9 pies per unit from 1st April, 1938, in the City of Bombay and in the areas covered by the following licenses:

(1) The Ahmedabad City Municipality and District Local Board Electric License.

(2) The Surat City Municipality and District Local Board Electric License.

(3) The Thana Electric License.

(4) The Bhiwandi Electric License.

(5) The Kalyan Electric License.

(6) The Poona Electric License.

(7) The Belgaum Electric License.

(8) The Bombay Suburban Electric License.

Government is pleased to note that in the areas in which the duty has been increased, the Supply Companies concerned have reduced their rates for supply with the result that the burden of extra taxation does not fall upon the consumers. In some of the areas a reduction in rates of even more than the three pies increase in duty has been made, still further benefiting the consumers. The supply companies have been wise in reducing the rate charged per unit of electricity of consumption in proportion to the increase of the duty imposed by the Government. We wish the Companies went a step further and make still larger reductions which cannot, we are sure, decrease their income, for such reductions will only increase the number of their subscribers, and therefore inflate it.

Improvement of Grazing and Fodder in Bombay

The All-India Cattle Conference at its meeting held at Simla on 25th and 26th May, 1937, recommended that Standing Fodder and Grazing Committees should be established in all provinces on the lines suggested by the Board of Agriculture and Animal Husbandry in India. In pursuance of the recommendation of the Conference, the Government of Bombay have constituted a Provincial Fodder and Grazing Committee consisting of official and non-official members to examine and advise on all matters connected with the use and improvement of grazing, grass and fodder of all descriptions.

The Honourable Minister for Revenue, Rural Development and Agriculture, will be the Chairman and the Commissioner, Central Division, Vice-Chairman

of the Committee. The Livestock Expert and the Working Plans Officer, Central Circle, for the time being will work as Joint-Secretaries of the Committee and will be responsible for calling meetings and conducting the correspondence of the Committee.

The Committee will ordinarily meet twice a year and will have power to co-opt for any meeting any official or non-official persons whom it thinks fit.

The Committee will be a purely advisory body and its functions will be: -

(*a*) to arrange for a survey and classification of all lands in the Province which on account of climatic, topographic or economic reasons are best suited for management as pastures. This definition would include wooded pastures, true pastures and intermediate types and would provide for the inclusion in each, where necessary or desirable, of lands marginally or submarginally suitable for cultivation as being capable of carrying an occasional field crop but requiring long intervals either as fallow or under grass in order to restore fertility. In addition the survey should include an estimation of the resources of cultivated fodder in the different districts of the Province;

(*b*) to examine the incidence and adequacy of such lands and fodder resources throughout the Province in relation to the location and numbers of livestock essential for the proper economic pursuit of agriculture and livestock breeding;

(*c*) to ascertain the present ownership or sources of control over such lands and to examine the adequacy or otherwise of existing organisations for managing such lands on proper lines, and to make recommendations;

(*d*) to examine existing methods of management of such lands and to make recommendations for improved methods which might be adopted for the attainment and maintenance of the maximum production of fodder and grazing in the manner most useful to agriculturists and breeders of livestock;

(*e*) to consider all schemes for improvement of grass lands, rotational grazing experiments, fodder storage, etc.;

(*f*) to devise methods for making use of spare irrigation water for raising grass and other fodder crops.

The Committee will work through the Government departments and the district village improvement associations. Government would refer to the Committee cases for opinion and would, as far as possible, issue orders in the light of its opinion subject to financial considerations.

The function of the Provincial Agricultural Research Committee constituted by Government in conformity with the recommendation of the Royal Commission on Agriculture is to advise Government on programmes of agricultural research to be submitted to the Imperial Council of Agricultural Research on applications from persons within the Province for grants from that body and also on any scheme or project which may be referred to it by Government for opinion. The Imperial Council of Agricultural Research, however, considers that in cases where the Provincial Fodder and Grazing Committee may have any schemes of All India importance to send up to the Council, it should not be necessary for such schemes to come through the Provincial Research Committee. Such schemes of All-India importance will therefore be submitted to Government direct by the Provincial Fodder and Grazing Committee for transmission to the Imperial Council of Agricultural Research.

Charges for Electricity

"The Truth About the Price of Electricity in the Home", is the title of a booklet published by the British Electrical Development Association. It gives the results of an independent survey by a Fellow of the Royal Statistical Society which show that more than 97 per cent. of the *domestic electrical consumers* of Great Britain can buy their electricity at 1*d.* a unit or less, that 60 per cent. of consumers can buy it at ½*d.* a unit or less and 85 per cent. of consumers at ¾*d.* a unit or less. It is pointed out that these prices are made possible by the all in domestic rate which has been adopted by the majority of electricity supply undertakings in Great Britain. These figures, which were the result of calculations based on the number of actual consumers who can buy at the different rates, were compared with data based upon the total number

of houses (whether connected to the mains or not) in the areas covered, and this survey gave practically as good results. This fact may be considered surprising, as in the latter case, many houses are included which are far from the load centres. It is said to be unlikely that any general increase in the selling price of electricity will be necessary because the cost of coal is a relatively smaller proportion of the total cost of production than with gas.

— *The Electrician.*

National Institute of Sciences of India

The symposium on 'Recent work on the synthesis of naturally occurring substances', under the auspices of the National Institute of Sciences of India will be held at Bombay on the 26th and 27th September, 1938. The programme of the meetings is as follows:—

Monday, the 26th September.

10-0 A.M.—12-45 P.M.	Address by Dr J. N. Ray and reading of papers.	R. I. Sc. Room No. 32.
1-0 P.M.— 2-30 P.M.	Lunch .	Mongini's Restaurant.
2-45 P.M.— 3-45 P.M.	Visit to the Department of Chemical Technology.	
4-30 P.M.— 6-0 P.M.	Formal Opening of Symposium by the Vice Chancellor of the Bombay University.	Sir C. J. Hall (University.)
6-30 P.M.	Public lecture by Dr S. S. Bhatnagar on 'How Chemistry can help Indian Industries.'	Sir C. J. Hall (University.)

Tuesday, the 27th September.

10-0 A.M.—12-45 P.M.	Reading of papers	R. I. Sc. Room No. 32.
1-0 P.M.— 2-30 P.M.	Lunch .	Mongini's Restaurant.
2-45 P.M.— 4-30 P.M.	Business meeting and reading of papers.	R. I. Sc., Room No. 32.
4-30 P.M.— 5-15 P.M.	Tea by Dr K. B., A. K. Turner, President, Indian Chemical Society, Bombay Branch.	R. I. Sc., (Library.)
5-15 P.M.— 6-15 P.M.	Lecture by Prof. J. C. Ghosh.	Sir C. J. Hall (University.)
6-30 P.M.	Public lecture by Dr M. N. Saha, F.R.S., on 'Geography of Space.'	Sir C. J. Hall (University.)

A Basis for World Peace

We are glad that a number of distinguished men of Science amongst others Sir A. S. Eddington and Sir F. Gowan Hopkins— have been trying to work out 'a basis for world peace' and has issued the following circular letter:—

A number of distinguished men and women—representative of the Church, Science and Letters, Heads of Universities and Colleges, and others—have expressed their approval of the principle for world peace. The Governments of different nations have become entangled in a net-work of suspicion; fear of one another has driven them to place their ultimate, if not their sole, reliance upon force. In these circumstances the most hopeful course of action is to seek to remove the grounds for suspicion by raising the problem of international relations on to a higher plane. Many people in every country feel strongly that the arbitrament of force— at best a confession of failure—can be and must be avoided. They look eagerly to those who are capable of leading opinion to secure a return to reasoned discussion on the part of all nations, whether they be at war or at peace. Even to those at peace, if it be a peace that is only a preparation for war, burdened as they are with the heavy cost of armaments and with an ever-present anxiety about what is to come, progress in the things that really matter is blocked.

There is therefore under consideration the possibility of forming a World Foundation of people of good faith who accept, and are prepared to do what they can to promote, the principle here formulated as the only trustworthy guide to action on the part of our own and every other responsible Government. The Foundation would be essentially *a league of peoples, not of Governments,* but it would seek to co-operate with and so strengthen any Government and any organization working along the same lines. True to its supernational character, its main purpose would be to devise and advocate ways of translating its fundamental principle into concrete action.

NOTES AND NEWS

As an illustration of the sort of action contemplated, the British Government might be encouraged to carry its conversations with other Governments a stage further. All might be invited to join in setting on foot an expert and impartial survey of the wealth of the world. If we are to seek to satisfy the basic needs of every nation upon terms that are recognized as reasonable and just, it is clearly necessary to begin by ascertaining as accurately as possible the nature and extent of each country's resources in land and people, in raw materials and technical equipment, and any potential outlets there may be for surplus populations. Much has been done in this direction already by the League of Nations, the Royal Institute of International Affairs, and other responsible bodies. Again, if international trade is to prosper and adequate provision is to be made for a rising standard of life, especially in backward countries, steps must be taken sooner or later to remove the accumulated restrictions upon the flow of commodities. Here M. van Zeeland, in his valuable report on economic collaboration, has made proposals which merit the serious attention of statesmen.

Leaders of thought in different fields would be capable of promoting the objects of the World Foundation in very different ways, and it would therefore be wise for each distinct group to form its own separate section, controlled by its own officers and executive committee. Scientists, for instance, might form one section, Writers another, Heads of Universities and Colleges another, and so on. Such a formation would have the additional advantage that the members of each section would know and could establish contact with workers in the same field in other countries. But all sections should be linked together, however loosely, seeing that all would be pursuing the same end in their several ways; and from time to time representatives from each might confer in regard to united action for certain common purposes. By this plan associated nuclei of thinking men and women would be formed throughout the world, capable, by concerted action, of bringing powerful influence to bear upon the course of international events.

It would be fitting that scientists, many of whom feel a deep concern on account of the evil uses to which their researches are sometimes put, should take the lead by forming a scientific section of a World Foundation on these lines. Other groups might well follow their example. The development of the scheme will depend entirely upon the measure of encouragement it receives, and the purpose of this communication is to test feeling among British scientists. Assuming it receives adequate encouragement, an opportunity for the discussion of the tentative suggestions here made, and related matters of importance, will be arranged by means of a Conference at an early date.

We are entirely in accord with the noble sentiments expressed in the above circular letter, and hope that the Angel of Peace would be able to overcome the Demon of Strife. As many of the promoters of the organization have visited India as delegates to the Silver Jubilee Session of the Indian Science Congress, they must have acquired some first hand knowledge of the conditions of life in India. We hope they need no argument to be convinced that India is a backward country, and the standard of life must be substantially raised— at least eight or ten times its present economic life. They have also noticed that India possesses in her scientists, a band of men actuated by sentiments of work and service to the country. Probably the delegates might have also grasped why India continues to be poor, while her soil is rich and resources almost unlimited. We hope that consistently with the noble sentiments expressed here, they will preach *practical* benevolence to their statesmen and politicians in matters dealing with India.

SCIENCE IN INDUSTRY

Growth of Indian Tea Industry

"Capable of producing over 500 million pounds of tea, there is a capital invested in India's tea industry to the tune of some Rs. 97 crores," according to the chairman of the Indian Tea Market Expansion Board in his broadcast talk. "The export trade in tea from India was only 235,000 lbs. in 1853 but today it is of the proportion of 334.7 million lbs. annually, representing a value of Rs. 24.38 crores."

"Tea is a bush plant which if allowed to grow uncared for would reach the dimensions of small trees. Planted as a seedling in the nursery, carefully tended and then transplanted to the main garden with hundreds of thousands of others, it is allowed to grow unchecked - all weeds and such like jungle growth alone being checked to permit of its receiving the greatest nourishment from treated soil—until such time as it receives its first pruning. This is a process which varies from district to district and even from garden to garden. The main object is, however, the same: to keep the plant at a reasonable height and to stimulate the growth in the correct manner so that the best production may result. Hundreds of women are then employed in the process of plucking the leaves and, generally speaking, only the bud and the first two leaves are taken from each stem, though the third somewhat coarser leaf may also be harvested. These leaves are collected by the pluckers in baskets and removed to the factory where they undergo four principal processes: withering, rolling, fermenting and firing.

"Your tea is, however, not yet ready for despatch to you: it must be sorted and graded, processes carried out by hand and by machines so as to separate it into different sizes and qualities to suit the various markets and blenders. It is then packed in chests and forwarded from the garden to the various markets of the world where it is tested by those who are expert in placing a value which the planter should receive on the tea he has produced; purchased by big dealers in tea who employ men to blend it to suit the needs of your particular requirements; and then sold in packets or in tins in its final state before it enters your teapot.

"Tea is a product which has limitless bounds in its distribution: it is one which in its development and manufacture is a triumph of industry, science, and business enterprise, bringing prosperity to millions and making the teapot the symbol of comfort and refreshment in homes all over the world."

The Working of the Indian Cane Factories

The working results of Modern Cane Factories for the season 1937-38 are now available. The total production of sugar by the factories in India for the season 1937 38, according to the estimate of the Indian Sugar Mills Association comes to 923,650 tons as against the actual production of tons 1,111,400 for the season 1936-37. This figure is based upon actual returns received by the Association from more than 90% of the factories working for the season while the figures in respect of the remaining few factories have been estimated either on the figures of cane crushed, wherever available, or on their daily crushing capacity and the number of days worked. The decline in the production of sugar during the last season as compared to the previous season was due to the shortage of cane supply in several districts. The season was of a shorter duration, the factories having worked on an average for 114 days only as compared to 144 days during the previous season. The season was particularly short in Bihar where the factories worked only for 100 days on an average as against 155 days in the previous season. The recovery of sugar during the season 1937-38 was 9.29% whereas the final figure for the previous season was 9.50 percent. The low recovery might be attributed to the inferiority

of cane and the prevalence of cane diseases in various parts of U.P. and Bihar. The production of sugar by factories in Burma for 1937-38 has been estimated at Tons 26,850 against the actual production of Tons, 17,550 during 1936-37.

Protection Urged for Sericultural Industry

The sericultural industry which has developed in various parts of the country principally in Bengal, Mysore, Assam and Kashmir is esentially a rural industry. In Bengal before the onset of depression there were 33,451 rearers and 17,555 acres under mulberry. By 1933-34 the number of rearers had fallen to 18,592 and the mulberry area to 10,032 acres and in 1936-37 the number of rearers and acreage under mulberry stood at 15,180 and 9,448 respectively. In other parts of the country also the same tendency was the main reason for the set-back the industry has suffered during the past several years. According to a communication addressed to the Tariff Board by the Committeee of the Indian chamber of commerce, the most important factor on account of which such uneconomic prices prevail was the competition of foreign countries. In 1931-32, the Committee point out, raw silk worth Rs 62,27,467 was imported into India from China and Japan and this increased to Rs 94,67,262 in 1937-38. Moreover, the import of artificial silk, an indirect competitor of raw silk, rose from 11,000,000 lbs. in 1932-33 to 17,000,000 lbs. in 1937-38. In the face of such severe foreign competition indigenous industry has hardly been able to subsist. The Committee refer to the Report of the Department of Industries Bengal, and state that the fact that the industry exists in such hard times of competition is mainly due to the profession of silk worm rearing being pursued by labour which was otherwise unproductive and would have remained unemployed.

The Committee refer to the various improvements effected in the industry during the past few years and state that sufficient time should be allowed to the industry to reap the benefits of the improvements. As emphasized by the Committee in view of the important place the industry occupies in the rural economy of the country, the existing protection to the industry should be continued for a further period of ten years.

Our Industrial Article for September

The article on the Manufacture of Synthetic Ammonia and Nitrogenous Fertilisers has been contributed by Mr N. G. Chatterjee of the Harcourt Butler Technological Institute, Cawnpore for our Section of Science in Industry of the present issue of the Journal.

The Manufacture of Synthetic Ammonia and Nitrogenous Fertilisers

N. G. Chatterjee

It is an established fact that Indian soils are very deficient in nitrogen, so that a matter of primary importance for agricultural improvement in the country is a plentiful supply of indigenous fertilizers. The natural supply of the latter from indigenous sources is very limited; and hence the use of synthetic compounds imported from abroad has of late been rapidly growing.

Almost every country in the world has been developing the nitrogenous products industry, and on account of its immense national importance, it is the one essentially chemical industry which has been subsidized lavishly by the State. Of course, the primary reason for State help to establish the industry has been not so much to produce fertilizers as to secure a plentiful supply of munitions in times of war, for explosives are mostly nitrogenous compounds. This point is of great importance and must be carefully borne in mind when

considering the economic aspects of the industry in India, for there is every likelihood of objections being raised to show that the cost of production of synthetic ammonia and its compounds would be in excess of the cost at which they could be imported. But such objections should be brushed aside on account of the fact that the products of these explosive munition factories are in reality being dumped into other countries in order to keep the plant in an efficient state of working during peace time, and that therefore the export prices of these products fixed by the various countries are in most cases below their legitimate cost of production according to established rules of works accountancy.

Some of the Provincial Governments are now seriously considering the establishment of some large-scale industries with active help of the State. It is submitted that the synthetic nitrogenous products industry ranks first in merit in this respect, for, on the one hand, the products are of national importance both in time of peace and war, and, on the other, it is of such a nature that purely private enterprise is neither sufficient nor desirable to establish the industry.

The conditions in the United Provinces and also in Chotanagpur are quite favourable for the establishment of this industry. The hydro-electric power available in the Western area of the U.P. may form the nucleus in devising a working scheme for the establishment of a small composite chemical works, producing electrolytic caustic soda, and using the hydrogen evolved to manufacture synthetic ammonia and ammonium compounds.

In Chotanagpur, due to the coal fields, the conditions are very favourable for the establishment of a central national nitrogenous fertilizers factory, producing hydrogen from coke by the "iron-contact process" and utilizing the nitrogen of the air by liquefying the latter.

The requisite plant has already been standardized by various manufacturers, and their successful operation may now be guaranteed.

A preliminary idea about the importance of the industry so far as India is concerned may be had from a perusal of the note attached. In case Governments feel sufficiently interested, detailed investigations may then be taken up.

Outlines of the Process of Manufacture of Nitrogenous Fertilizers by the use of Synthetic Ammonia

In Germany the first ammonia synthesis was successfully carried through by the Badische Anilin and Sodafabric according to the process of Prof. Haber. The first plant was erected in 1913 and a year later this was extended to much greater capacity. Together with the output of the Leunaworks of the same company (now the I. G. Farben industries A. G.) about 400,000 tons of nitrogen are now produced in Germany in the form of nitrogenous fertilizers, nitrates, etc., per annum.

During and after the War, the synthetic process of "Claude" was developed in France; in Italy at the same time research took place and the process of "Casale" and "Fauser" were developed, and in America the process of the Nitrogen Engineering Corporation. In the main these processes differed from one other only in the size of units and the pressure and temperatures used. Naturally, the catalysts over which the hydrogen and nitrogen are led also vary in the different processes. The capacity of the plant depends largely on the method employed, and the nature of the catalysts. The smallest economic capacity of the "Haber" process is many times greater than that of the other, so that this process can only be considered for large units.

In general the cycle of operation of these processes is as follows:

Hydrogen and nitrogen in the proportion of 3: 1, are mixed at a certain temperature and under a pressure of about 100 atm., and are then led through a catalyst. There they combine to from ammonia (NH_3), which is produced either in the form of liquid ammonia or ammonia solution. As only partial reaction takes place repeated circulation of the ammonia in the apparatus is necessary in order to produce the required concentration. Therefore this process can be considered as a completely continuous process. The gases used, *i.e.*, hydrogen and nitrogen, must be of great purity to avoid damage to the catalyst. The produced ammonia is in the form of gas in this state is subjected to further treatment.

As previously stated, the "Haber" process is advisable for large size plants. The units of other processes have a capacity of 7½-10 tons per day and are recommended in cases where only a small production of nitrates or nitrogenous fertilizer is required. Synthetic ammonia produces about 3 times its weight

of concentrated nitrates. The plant (*i.e.*, the nitrogen factory) can be operated to produce only a small amount of concentrated nitrates per day, so that individual plants can manufacture synthetic ammonia either for stock or for immediate use in producing nitrogenous fertilizer.

For the synthetic process, as far as is possible, pure hydrogen and nitrogen are required. For the production of hydrogen various processes are used. If electric power is cheap and is available in sufficient quantities, hydrogen can be produced by the electrolytic process.

If electric power or any other cheap power is not available, hydrogen can be suitably produced by the iron-contact process.

With this process iron-ore is used to disintegrate steam into hydrogen and oxygen. The oxygen of the steam oxidizes the glowing iron-ore, while the hydrogen leaves the apparatus in the form of gas. The method of operation of such plants is intermittent, *i.e.*, after oxidizing with steam, the oxidized ore or metallic iron must, by means of a reducing gas (which can either be water gas or coke oven gas), again be reduced to metallic iron. When this reduction has taken place the iron-ore content of the shaft is again suitable for the disintegration of steam, *i.e.*, the production of hydrogen. In consequence of the special construction of the catalyst chamber the iron ore content is retained by the simplest method continuously at the reaction temperature.

The nitrogen is produced by means of an apparatus which operates on the principle of the liquefaction and separation of the constituents of air by diffusion. The apparatus consists mainly of the liquefaction and separation plants, the compressing plant and the apparatus for cleaning, drying and pre-cooling the air.

The hydrogen and nitrogen produced by the above-mentioned plants are now transformed by synthesis into ammonia. Of this ammonia the pure water-free ammonia must be further treated either for the production of nitrogenous fertilizer or for concentrated nitric acid, while the liquid ammonia produced in the ammonia synthesis is led to intermediate tanks and from these into an evaporator in which, by means of a piping system, it is heated by water and boiled. The ammonia vapours leave the evaporator and go from there into the pressure apparatus, in which they receive the small additional pressure necessary for filling the gas holder. This holder is specially constructed for receiving the ammonia gas and is provided with a heating apparatus as well as an indicator. The evaporated ammonia produced is now transported either direct into nitrogenous fertilize (for example, ammonium sulphate) or is burnt for the production of nitric acid, ammonium nitrate, sodium nitrate or calcium nitrate, or can put in cylinders in the anhydrous condition for use in factories. For the sake of clearness it should be stated that the production of ammonium nitrate evaporated ammonia is required. The ammonia gas is by means of an exhauster sucked out of the ammonia gas tank, the connection between the exhauster and the tank being a cast iron piping system of the necessary size. The exhauster delivers the ammonia gas by means of a similar cast-iron piping system to the mixing chamber in which it is mixed with purified air in a defined proportion. This mixture of air and ammonia is now led to an apparatus made of aluminium, in which it is burnt over a catalyst. There now exists a hot mixture of nitric oxide, steam oxygen and nitrogen, which is led over a heat exchanger plant to the condensation plant. The nitrogenous gases now go to a re-cooler which consists of coolers and internal spraying towers of acid-resisting metal. There the actual condensation and absorption take place. As a certain amount of heat is formed by the oxidation of the nitric oxide and by the solution of nitric acid in the water, the used acids for spraying the towers are cooled between the towers. The flow of the acids from tower to tower takes place by means of pumps of acid-resisting metal. The distributing apparatus and the ample filling of the towers ensures complete washing of the gases by the syraying liquid. The final product is a nitric acid of 33-36° which is stored in stone receptacles.

Concentrated Nitric Acid

There now remains to concentrate the nitric acid already produced. For this purpose, it is mixed with approximately double the amount of concentrated sulphuric acid and the mixture passes down the tower in uni-flow, whereas the steam passes upwards in counter-flow. The concentrated sulphuric acid absorbs water and condensed steam. The nitric acid leaving the tower is condensed and cooled and is discharged into store tanks as 37-38% pure acid.

The other products that may be made are (*a*) Ammonium Sulphate, (*b*) Ammonium Nitrate, (*c*) Sodium Nitrate, (*d*) Calcium Nitrate.

Below we give for the information of the reader

the statistic of the import into India of some nitrogenous chemicals and fertilizers during 1936-37.

Article.		*Quantity.*	*Value.*
Nitric Acid	..	2,275 cwt.	Rs. 26,771
Anhydrous Ammonia	..	2,760 „	„ 309,059
Carbonate and Bicarbonate of Ammonia	..	10,812 „	„ 1,82,897
Nitrogenous Manures—			
(*a*) Ammonium Sulphate	..	61,238 tons.	„ 58,43,656
(*b*) Ammonium Phosphate	..	4,122 „	„ 6,14,587

Scheme of a National Central Factory

Now we proceed to give the outline of a scheme for the manufacture of synthetic ammonia and fertilizers in a National Central Factory in this country.

Location of the Factory.—The Factory is to be erected in the coalfield area of Chotanagpur, the exact location being chosen after due consideration of the marketing conditions and proper shelter from aerial attacks.

Products to be Manufactured.—The basic product of manufacture would be synthetic ammonia, which is the starting point for making nitric acid required for explosives, and for ammonium sulphate for agricultural purposes (fertilizers). Ammonia is also an important raw material for making urea which is being used as a fertilizer and also for synthetic resins. In short, the factory is to be the central point in the national defence scheme of the country in time of war, and in national prosperity in agriculture and industries in time of peace.

The chief raw material would be coal, which would be subjected to a variety of preliminary treatment in order that it may be utilized not only in the most efficient manner, but may also have the potentialities of future expansion in the synthetic chemical industries from high pressure gas reactions. Hydrogen required for synthetic ammonia would be prepared from coke, and nitrogen would be obtained from liquid air.

Capacity of the Plant.—It is proposed to have a plant for producing 10 tons of ammonia per 24 hours. If the whole of this be converted into ammonium sulphate, the quantity of the latter would be about 14,000 tons per annum.

Requirements of Raw Material and Powder

PER TON NETT OF AMMONIA

1. *Fuel.* (*a*) Coke for hydrogen generation .. .. 2·0 tons.
   (*b*) Coke for steam generation, etc. .. .. 1·3 tons.
2. *Power.* Total .. .. 3,300 H.P.H.
3. *Water* Total .. .. 30,000 Cu. ft.

PLANT COSTS.

1. *Ammonia Section* .. .. Rs. 23·10 lakhs.
   (*a*) Gas manufacture .. Rs. 6·50 lakhs
   (*b*) Compression & purification .. „ 6·75 „
   (*c*) Ammonia process .. „ 6·10 „
   (*d*) Plant facilities „ 3·75 „

   Total .. Rs. 23·10 lakhs
2. *Power Section* .. .. Rs. 3·50 lakhs.
3. *Acid and Sulphate Section* .. „ 4·50 „

   Total Physical Plant costs .. Rs. 31·10 lakhs.
4. *Overhead costs (during construction)* „ 3·00 „

   Total Plant costs .. .. Rs. 34·10 lakhs.
   or say Rs. 35 lakhs.

CAPITAL INVESTMENT

On Plant..	..	Rs. 35·00 lakhs.
Working Capital	..	„ 5·00 „
		Rs. 40·00 lakhs.

FIXED CHARGES

1. *On Plant.*
   Depreciation at 5% on Rs. 35 lakhs Rs. 1·75 lakhs.
2. *On Invested Capital.*
   Interest at 5% on Rs. 40·00 lakhs „ 2·00 „
   Taxes and Insurance at 2% .. „ 0·80 „

   Total fixed charges .. Rs. 4·55 lakhs.

   or, per ton of ammonia Rs. 130.

AMMONIA PRODUCTION COSTS

Per ton of ammonia.

(In this is included the fixed charges, overheads,

maintenance, etc., on account of investment on the synthetic section.)

Process operation	.. ..	Rs. 136
General plant expense ..	..	„ 34
Running maintenance ..	..	„ 54
Miscellaneous and Contingency	..	„ 21
Total operating costs	..	Rs. 245
Total fixed charges	..	„ 130
Total production cost	..	Rs. 375

Total production cost of synthetic ammonia is estimated to be about Rs. 375 per ton.

The production cost of ammonia sulphate may be estimated by adding the raw materials cost of sulphuric acid.

Cost of production in other countries.

Reliable information is very difficult to obtain, but from data published in verious scientific journals, the cost appears to be near about the same as given here. It need however be hardly pointed out that accountancy methods are to a large extent responsible for any marked departure from this normal figure. Further, the recoginzed policy in the ammonia trade has been to market ammonium sulphate at cost price or even lower, in order to dispose of the surplus ammonia that cannot be sold in any other form.

Production of Ammonium Sulphate (Synthetic and by-product)

In metric tons (000's omitted)

	1931	1932	1933*
India (only by-product) ..	12	10	10
Japan ..	393	460	471
Germany ..	1,244	965	..
United Kingdom ..	532	638	584
United States ..	446	261	308

World Production and Consumption of Nitrogen

In metric tons (000's omitted)

	1932-33	1933-34	1934-35
Production			
Ammonium Sulphate	817·7	841·8	835·7
By-product ..	257·7	307·1	315·9
Synthetic ..	560·0	534·7	519·8
Calcium Cyanamide	168·5	195·2	238·5
Nitrate of Lime ..	118·2	107·2	153·1
Chile Nitrate ..	70·8	84·3	178·4
Other forms of Nitrate ..	501·7	563·8	635·7
By-product ..	39·6	48·3	44·4
Synthetic ..	462·1	515·5	591·3
	1,676·9	1,792·3	2,041·4
Consumption			
Manufactured Nitrogen	1,619·7	1,714·0	1,836·5
Chile Nitrate ..	127·2	163·6	194·4
Total Consumption	1,746·9	1,877·6	2,030·9
Of which Agricultural	1,586·0	1,673·0	1,792·0

World Production and Consumption of Nitrogen
In metric tons (000's omitted)

—From *Statistical Year Book of the League of Nations*, 1935-36

* Later figures are not available for all the countries.

MEDICINE AND PUBLIC HEALTH

Recent Researches on Surgical Complications of Filariasis

Next to Malaria, Filarial infection is the most wide spread disease in certain parts of India. Although the rate of mortality is not as high as in Malaria, the amount of disability and suffering is enormous. Much work has been done at the school of Tropical Medicine in Calcutta and elsewhere on the medical and surgical complications of filariasis. Filarial diseases are generally characterised by the formation of varicosity of the lymphatics and oedema and fibrosis of the extremities. In all these cases the initial damage to the lymphatic system is brought about by the parasites, secondary infection aggravating the disease. Cases are, however, known where the pathological process is due solely to the parasite without any evidence of secondary infection. As no satisfactory specific for filarial infection is known at present, surgical treatment has often to be resorted to, particularly, in cases of lymph scrotum, hydrocele, epididymo-orchitis and elephantiasis.

In this connection, the recent investigations by Mr P. N. Ray, M.B., F.R.C.S. (Eng.) on chronic epididymo orchitis are specially interesting. In a paper read in 1933, at a clinical meeting of the British Medical Association, Clacutta Branch, he demonstrated with the aid of microscopic sections and slides the pathological changes which are seen in the typical case.[1] Sections of the adult female worm (*Wuchereria bancrofti*) and numerous microfilariae contained within the uterus, were seen both in the testes and epididymes. In these cases no evidence of secondary pyogenic infection could be seen. The conclusion was reached that the adult filaria was the real cause of the pathological changes in the testicle and the epididymis. Further work carried out on this subject at the Calcutta School of Tropical Medicine and by Mr Ray on 'filarial infections of the male genital tracts'[2] confirmed these findings. Detailed references to this important work may be found in some recent English works on Surgery dealing with the diseases of the male genital tracts.[3]

— *S. S. R.*

[1] *British Journal of Surgery, 22*, 264-268, 1934.
264-268.

The Climatic Sanatorium

At one time it was the fashion all over the world to send tuberculous patients to a good climate for the cure. With the advancement in the methods of treatment it is justifiably realised now that good and adequate medical treatment is far more important than climate treatment alone. Yet the value of climate, though very much overrated in those days, is still recognised. Tuberculosis is a wasting disease with a very prolonged course even when the patient is proceeding towards recovery. It is why a climatic sanatorium affords many advantages to such a patient. A Sanatorium is generally situated at a high altitude which raises the metabolism of the body. The body, therefore, could be better nourished. The daily and seasonal variation of temperature, the dampness of the place etc. are generally less than the plains climate. These minimise the stress and strain on the economy of the body. The Sanatorium opens out to a patient an expanse of free space with beautiful sceneries which enhances his well-being. Because of the more bracing climate and

[2] *Indian Medical Gazette, 69*, 554-558, 1934.

[3] *Diseases of the Testicle* By Hamilton Bailey, F.R.C.S. (Eng). (H. K. Lewis & Co. Ltd. London).

Recent Advances in Genito-Urinary Surgery. By Hamilton Bailey, F.R.C.S. (Eng.) and N. M. Matheson, M.B., F.R.C.S. (Eng.) (J. & A. Churchill Ltd., London).

beautiful foot-paths to take graduated walking exercise a patient feels less fatigued than in the ordinary climate.

For the above mentioned reasons a climatic sanatorium is ideal for people who are not suffering from the acute symptoms of the disease *e.g.*, high temperature, frequent haemoptysis, very high pulse rate etc. A patient who can move about without the raising of temperature and pulse benefits most from a sanatorium.

Now a days a sanatorium is usually well-equipped with medical staff and opportunities of modern treatment. The patient gets the benefit of all types of surgical treatment of the disease which, in recent times, has gained a very large ground in the treatment of the disease. The patient derives the advantages of the climate and as also of the more important factor -good medical care. The result, therefore, is an all-round gain for the patient.

We give, herewith, the amenities and results of treatment of one of the climatic sanatoriums of India.

The Annual Report of King Edward VII Sanatorium, Bhowali, U. P. for 1937

The Sanatorium is situated at an altitude of 6,000 ft. above sea level. It is situated in the hills covered with vegetation and away from crowded habitations. Its atmosphere is free from smoke and dust.

The climate is dry and bracing throughout the year. The average annual rainfall is 83 inches. The average mean temperature from March to November is 76°F with a minimum of 50°F and a maximum of 90°F. It is colder from December to February but the climate is invigorating.

In the year under report the Sanatorium has an accommodation for 142 patients. A number of social events and recreative diversions in the way of Tea parties, At Homes, Jugglers shows, Cinema shows etc., are arranged from time to time. The Sanatorium possesses a General Library for books on various subjects in Hindi, Urdu and English, newspapers and periodicals and a medical Library for books and journals on tuberculosis and general medicine.

During the year, 236 patients are admitted into the Sanatorium, 245 treated and 213 discharged. Of these 213, very few cases (10) occur between 5-15 years and the number increased more rapidly after this age period. The incidence again is more rapid and the maximum reaches earlier in the famales than in the males between 5-20 years.

The greatest number of patients occurs among the Hindus, majority of which comes from the Kayastha and Vaishya communities. The incidence is also found to be greatest among the married people. Regarding occupation, the largest number of patients comes from the student class and next in order from the housewives and clerks.

Of the 213 patients discharged from the Sanatorium, 13 stayed there for less than a month and 9 were free from active disease. Of the remaining 191 cases 150 were males and 41 females and the disease was slight in 25, moderately advanced in 38 and far advanced in 128 *i.e.*, in more than half of the patients. Majority of this latter class of patients showed, on admission, a range of temperature from 90°F to 102°F and above. The tubercle bacilli were present in 68.6% patients on admission and remained present in 50.3% at discharge and this is found mostly in the far advanced cases.

As regards the results of treatment, 30.3% of patients were arrested, 12.5% much improved, 27.2% improved, 15 1% stationery, 13.08% worse and 1.5% dead. All with slight disease, 35 out of 38 of moderately advanced cases and 74 out of 128 of far advanced cases were arrested or improved.

Sanatorium routine treatment, Gold therapy, Artificial pneumothorax and Phrenic evulsion are the main methods of treatment adopted in this Sanatorium along with X-Ray work and laboratory examinations of sputum, blood, urine and foeces.

Medical Article for September

The following article on 'The Incurables' has been contributed by Bt.-Col. R. N. Chopra, Director, School of Tropical McMdicine, Calcutta for our 'Medicine and Public Health' section of the present issue of the journal.

The Incurables

R. N. Chopra

Director, School of Tropical Medicine Calcutta

From the earliest days of history, life has imposed its stress and strain upon mankind. The continual strife with the elements, the dreadful toils and dangers a man has to undergo, bring about ill health and disease which may end his uncertain existence. Man is terribly afraid of death, and makes every effort to prolonging life as much as possible. In order to accomplish this, the body should be kept in good working order and if ill health supervenes, it should be combated. Unceasing struggle has therefore been carried on against disease from the earliest days of man's existence. Gods and goddesses were created to protect him from evil, and deities in anger or demons were propitiated by charms and amulets. After centuries of struggle, the spirit of science dawned and with it the will to go into the exact nature of the causation of disease, by experiment and research. Thus a more rational way of fighting disease was evolved. In this struggle, workers in different ages, found that they could combat certain diseases with success, while against others they were powerless. These were termed *incurable diseases*. As science progressed many incurable diseases were conquered; what was regarded as incurable in one age, became amenable to treatment or preventable in another. Great scourges such as plague, cholera, small pox, leprosy, etc., are all in the process of being conquered. Development of preventive methods and advances in treatment, have succeeded in freeing people in the western countries from many of these pests. Unfortunately, because of our imperfect methods of dealing with them in India, they still take a heavy toll of life and leave a trail of woe behind.

Definitions and Types of Incurables

Ordinarily speaking, the term 'incurable' is applied to those unfortunate victims of disease, in whom treatment with all its advances is ineffective and the rate of advent of death cannot be influenced. Such diseases or conditions may be *acute* or *chronic*. An instance of the former is hydrophobia, an acute infective disease produced by a virus which is communicated to man by the bite of a rabid dog, jackal or wolf. When once the disease is established, there is no hope of recovery, but modern research has made its onset preventable by prophylactic treatment. Other diseases in this category are galloping phthisis, acute leukaemias, a number of infections diseases such as advanced tetanus, pneumonic plague, fulminating meningitis and acute poliomyelities. In the case of this group inspite of all efforts on the part of science the advent of death cannot be prevented, and the sufferer is relieved from his misery in a short time.

In the chronic type of incurable diseases, however, the unfortunate victim may go on suffering and lingering for prolonged periods. There are two main groups in this class. The first in which the disability produced is not marked in the early stages, and the individual afflicted may be able to carry on for many years without being a burden to society. Such conditions are diabetes, kidney and heart disease, epilepsy, early malignant disease, etc. Considerable advance has been made in the treatment of these diseases during recent years and they are rapidly becoming preventable or curable by the development of techniques of early diagnosis. To the second group belong those who are permanently incapacitated from earning their livelihood, and need active care by the community. Advanced phthisis, tubercular disease of bones and joints, blood diseases such as leukaemia, nervous diseases, epilepsy, leprosy and others may be included in this group. Science is making valiant efforts to bring them under control and success has attended in several directions. But cancer is a disease which has baffled medical science, and the problem of causation of this dreadful disease is still unsolved inspite of the enormous amount of scientific research. Not only do we not know what cancer is, we do not even know to what category of diseases it belongs, whether microbic, metabolic or degenerative. It is the stalking spectre among diseases and it is surrounded with all the horror which attaches to the incomprehensible. Medical research has made a large majority of cases of accessible cancer in early

stages, amenable to surgical, röentgenic (chaoul and deep X-ray) and radium treatment so effectively as to render recurrence unlikely. But unfortunately many cases are not seen early enough and in many more the seat of the disease is not accessible and in such cases the end is inevitable. No one who studies the rapid progress which the medical science is making can doubt that even this disease may become preventable or curable. Cancer accounts for a large number of incurables in the West, but fortunately its incidence is lower in this country. Those afflicted with it suffer intolerable pain and anguish, often for prolonged periods, before death relieves them of their misery.

The incurables belonging to the class of imbeciles, idiots, and those suffering from mental disorders, have presented difficulties so far as prevention and cure is concerned, in fact, the last named class has showed a definite increase on account of nervous strain imposed by life in large towns. These are adequately dealt with in most countries in asylums or mental hospitals, and science is evolving new methods of treatment for them. A visit to some of the institutions in this country will show what a large number of unfortunate people come into this category, who have no hope of being ever restored to health and who are a burden to themselves and to society. Then there are the maimed and paralysed individuals who are the victims of congenital defects, nerve diseases, advanced leprosy, lathyrism, street accidents, venereal and rheumatic infections, filariasis, etc. A very large group in this country are those afflicted with blindness, which is so often preventable. These people have generally suffered from diseases that have passed away but have left a terrible legacy behind. In many cases in this group the much needed care by the community is often not forthcoming and the sufferers are left to the mercy of elements. These unfortunate individuals account for the large proportion of the beggar class in large towns in India.

Statistics

This brief review of the incurable diseases, will give one some idea of the importance of this problem and what medical science is doing towards its solution. While in many of the western countries adequate arrangements are provided to ameliorate the lot of these sufferers, in India little attention has been paid to the problem. According to the last census report (1931), there are 120,304 insane, 230,895 deaf-mutes, 601,370 blind and 147,911 lepers in India. A very large number of the population of this country suffer from various debilitating diseases which not only considerably reduce the working capacity of the people, but many are rendered totally incapacitated. The Annual Report of the Hospitals and Dispensaries under the Government of Bengal (1935) shows that there are 100,626 cases suffering from venereal diseases or their sequelæ, 36,281 from tuberculosis of various forms, 6,508 cases of chronic leprosy, 24,810 of malignant tumours, 4,821 of filariasis causing definite disablement, and 4,129 cases of mental diseases, all of the incurable type. If this is the condition of one province in India, the condition of the rest of the country may be easily imagined. Only a small fraction of this large group are looked after. A cursory examination of the beggar class of any of the big cities will convince one of this.

It is to be greatly regretted that no organized effort has been made so far to deal with the important problem of incurables in this country. The public interest should be roused, and something should be done to bring into action the discoveries of medical science towards the prevention of incurability and proper care of the incurables. Illiteracy and ignorance among the masses are responsible for the production of a large section of the incurable class. Intensive educative propaganda is needed. One has only to see what has been accomplished in some of the Western countries, and to know how much can be done not only to diminish the number of incurables, but also to make the life of those who suffer from incurable affections less miserable and more contented. The platform, the stage, films, radio and newspapers combined have changed the whole aspect of the problem in the West. The same can be done in India.

Remedies: Research, Treatment and Establishment of Institutions

The causes leading to the creation of an incurable class should be thoroughly investigated and adequately dealt with. It has been roughly estimated that 30 per cent. of the maimed beggars on the streets of large towns such as Calcutta are drawn from advanced types of leprosy. Adequate treatment in the early stages would almost entirely eliminate this factor. Then there are a fair number of mentally deficient individuals and morons in every community and state, who can be easily

rehabilitated if proper care and attention is bestowed on them. Homes like the "Bodhana Samiti" have already made good progress in this connection. Lathyrism and elephantiasis could be stamped out if suitable preventive measures indicated by medical research are taken. About 10 per cent of the beggars are blind. Blindness may be present from birth but more often it is produced by small-pox, corneal ulceration, venereal diseases and nutritional defects, which are all preventable in the light of modern discoveries. It has been estimated that venereal diseases which are now preventable and curable are responsible for 40 per cent of blindness in children and 60 per cent in adults. The institution of eye clinics and travelling eye dispensaries will do much to reduce this group.

As regards the measures which can be taken to make the lot of incurables happy, much has been accomplished in the West, but even the fringe of the problem has not been touched in India. To start with, no accurate information is available with regard to the number of persons suffering from chronic incurable diseases. With the exception of a few homes for Europeans and Anglo-Indians, there are few dis-jointed organizations which interest themselves in this question. The Ramkrishna Mission Hospital in Benares is one of the few institutions in India where incurables are cared for, but the problem needs much wider attention. Apart from mental asylums there is a genuine need for public institutions for incurables who are unable to look after themselves.

Broadly speaking there are three types of incurable persons:—

(1) Those who require active medical aid in a hospital or infirmary.

(2) Those who need skilled nursing.

(3) Those for whom custodial care by competent attendants is necessary.

Well-organized homes and colonies should be started to deal with all these three groups. Apart from lunatic asylums a few such institutions exist for lepers, but all too inadequate, and none for other groups. The Calcutta Corporation has recently appointed a committee to go into the Beggar Problem which has a bearing on this problem of incurables. It has been estimated that there are more than 12,000 beggars in Calcutta alone. Many of them suffer from incurable disease. A proposal has been put forward to start a more commodious 'refuge' where such people can be looked after. In Bombay, a similar scheme is on foot and all other towns should follow this lead. Such places could contribute substantially to their own upkeep, if the inmates were taught a number of lucrative trades. A few institutions for the blind are already in existence and are doing excellent work. It may be emphasized that the Government and municipalities can help by giving grants to such organizations but they cannot be expected to shoulder the entire burden. The public should realize their responsibilities and come forward with donations as is done in western countries, to help in the solution of the problem of the incurables by promoting medical research and palliative measures. The responsibility of the State and society is at least as great towards this class as towards the acute sufferer from disease.

The migration of beggars to large cities and prosperous places should be prevented and the able-bodied beggars should be made to earn their living. A Vagrancy Act suitable to the conditions in India may be enacted and enforced by the municipalities, district boards, and other such bodies.

The industrial workers and others whose earning capacity is small could easily contribute small amounts commensurate with their means to a central organization, which would take care of them and their families in case of permanent incapacity and disablement. The employers, the State and the public could make contributions. In the present state of medical relief in India, with large numbers of unqualified practitioners of indigenous medicine, the introduction of a Health Insurance Act may present difficulties, but, sooner or later, it bound to come in some modified form and this will greatly help in the solution of this problem. The National Health Insurance Act was put on the Statute Book in England in 1924. All employed persons of either sex, of the age of 16 and upwards and certain voluntary contributors are entitled to the benefits in respect of health insurance and prevention of sickness. The expenses are defrayed by contribution of employees and employers, supplemented by money provided by Parliament. The benefits conferred are medical treatment and attendance, including the provision of proper and sufficient medicines. Sickness and disablement benefits and maternity benefits are also provided. Something of this nature could be started in India.

MEDICINE AND PUBLIC HEALTH

"Euthanasia" or Painless Killing

The problem of hopeless incurables who suffer from intense pain has lately been engaging the attention of people in the West. The Euthanasia Legislation Society in England has sponsored a bill for the solution of this problem which has been hotly debated. It has been proposed to put an end to people suffering from exerneiating pain of an intolerable and incurable nature such as of carcinoma in a painless and merciful manner if they so desired. Minors and insane people were excluded from the scope of this Bill. The patient with the consent of his relatives would have to make a request in writing on a prescribed form and to submit two independent medical certificates. The "referee" would satisfy himself about the presence of any abuse. Euthanasia is to be performed by a licensed doctor at a suitable occasion. The Voluntary Euthanasia Bill was introduced into the House of Lords but was not passed. The idea has received support from a section of the clergy but the physicians themselves are divided about its advisability. Some of the noble Lords preferred the continuance of illegal euthanasia to the rigid provisions of the Euthanasia Bill. While admitting the soundness of the principle of euthanasia one cannot help considering its practical effects. Besides the abuses which may follow, the sentiment is that no man has the right to take the life of another whether he be deformed, blind, deaf and dumb or dying. Such practice may be repugnant to many medical men who consider that their duty is only to cure and not to kill. There are many remedies and much more control of pain to-day than formerly, and it is the duty and privilege of the medical man, if he is not able to produce a cure, to do what he can to make the passage between painful illness and the inevitable end as gentle and comforting as possible.

In conclusion, I wish to say a few words about the relationship of medical research to the problem of incurables. The progress made through many decades of laborious research has paved the way for suppression of epidemic diseases such as small-pox, typhus, cholera, plague, enteric, etc., which used to decimate countries and are now paving the way for many others. Research in preventive medicine has brought the principles of prevention into their true perspective. In the light of recent advances the occurrence of such diseases in civilized countries is a matter of great reproach. Medical research has shown the way and exprience has proved the truth of the results that have been obtained.

In an editorial on medical research in India in the August number of the Calcutta Medical Journal, the writer has clearly brought out the lack of public interest in medical research in this country. In countries like Great Britain, large sums are set apart for medical research and investigation on other aspects of medicine than the curative side. This does not signify that curative side is any the less important, but the feeling is gradually gaining ground among the medical scientists in England, Germany, France and America that there are tremendous potentialities in the field of medical research other than curative and that all the available resources should be harnessed to strengthen medical research in its various aspects. In India unfortunately the contribution towards medical research by the State is very small as compared with the size of the country. From the public munificence the contributions are conspicuous by their entire absence. The reason for such neglect is that the true meaning, aim and objects of research are not understood by the public. Because research does not immediately lead to epoch making discoveries and does not always bring sensational results, the importance and value of medical research and the need for support by private individuals are not sufficiently appreciated. Until this is done, the problem of incurables will remain unsolved in this country.*

* Based on a broadcast talk from the Calcutta Station. Second lecture in "Progress of Science Series" of the All-India Radio.

Research Notes

Urinary Cholesterol in Cancer

The structural relation of several potent carcinogenic hydrocarbons to cyclopentenophenanthrene, which forms the cyclic portion of cholesterol, bile acids, and steroid hormones, has given rise in recent years to various speculations concerning the rôle which cholesterol and other steroid derivatives may play in tumor metabolism. Tumour tissue is known to be richer in cholesterol than any parenchymatous organ, exclusive of the brain so that cholesterol is linked in some peculiar manner with tumor metabolism.

The cholesterol excretion through the kidney is minute under normal conditions, but considerable amounts are found in the urine of nephritic patients and in chylous urine.

Bloch and Sobotka (*J. Biol. Chem.* *124*, 567, 1938) examined the urine of hospital patients and found in the urine from cancer patients an average of 400 mg. per 100 liters as against an average of 30 mg. of cholesterol per 100 liters of urine from normal individuals.

The rise of urinary cholesterol to more than 10 times the normal value may not be characteristic for cancer urine but a symptom common to any group of cachectic patients. Therefore, controls were run on urine from cardiac and consumptive patients; these gave figures of 50 and 20 mg. of cholesterol per 100 liters respectively, figures which correspond with the values for normal subjects. The authors attribute the high cholesterol level in cancer urines to the continuous destruction of tumour tissue.

The study of urines collected from individual patients will throw light on the question whether cholesterol urea is an expression of abnormal cholesterol metabolism or merely of increased catabolism of cholesterol rich tissue.

- *H. N. B.*

Composition of the Milk from the Breasts of Newly-born Infants

It is well known that most infants of both sexes secrete milk when newly born, the secretion being termed Witches' or Sorcerers' milk. The phenomenon is ascribed to puerpural involution in the mammary glands of the newly born infants, and the secretion is considered to be imperfect milk loaded with leucocytes, often ending in abscesses.

Five samples of such secretions were collected from infants of both sexes between 9 and 17 days old and submitted to analysis. Davies and Moncrieff (*Biochem. J.* *32*, 1238, 1938) obtained the milk by gentle squeezing of the enlarged breasts, the milk then being sucked up by a pipette and transferred to small glass bottles containing a trace of formalin. The yields were variable but in no case exceeded 1·8 g. Determinations were made of total solids, nitrogen distribution, sugar and chloride content and evidence of the presence of peroxidase and phosphatase. Fat and mineral content could not be determined for want of material, but all samples appeared to contain fat since they showed the property of creaming on standing. The highest total solids occurred around the 9th day, protein accounting for most (60-80%) of the solids. It is probable that the secretion is at first watery, rises in total solids and protein content to the 9th day, and then decreases in solids slowly and in protein rapidly, due to resorption in the following days. The secretions bear some resemblance in composition to those from the udders of pregnant

heifers and dry non-pregnant cows and tends to resemble colostrum in composition.

—*H. N. B.*

The Proximate Analysis of the Organic Constituents of Soils

J. M. Shewan (*J. Agri. Sci.*, *28*, 324-340, 1938), has analysed the organic constituents of several profiles from north-east of Scotland. He has used the system of analysis proposed by S. Waksman and K. Stevens (*Soil Sci.*, *30*, 97-116, 1930), but has used various modifications in order to obtain greater accuracy. Shewan points out that it is necessary in the ether extraction of the organic matter to digest the soil with ether for 24-30 hrs. instead of 10-16 hrs. as done by Waksman and Stevens. For the determination of cellulose fraction Shewan has used 80% sulphuric acid for 2½ hrs. at 12-14°C (Waksman does not control the temperature). Several other modifications have been recommended with respect to the determination of reducing sugars produced from the hydrolysis of hemicellulose and cellulose. The method which has been finally adopted for the determination of reducing sugars is as follows:

10-25 c.c. of the acid hydrolysate are neutralized, made alkaline to brom-cresol purple with 2.5% NaOH, allowed to stand for a few hours with frequent shaking, after which the iron-manganese precipitate is filtered and washed and the filtrate made up to 100 c.c. (In some cases two precipitations are necessary). Fehling's solution is added (Lane and Eynon's A and B), the mixture boiled and a standard glucose solution is run in until an end-point is reached, using 3 drops of 1% methylene blue as indicator. The whole operation must be completed 3 minutes after boiling commences. The standard solution is treated in the same manner.

The determination of the organic constituents of soil is very important, but so far no method, including that proposed by Waksman and Stevens, has been found to be satisfactory. The modified procedure proposed by Shewan seems promising and should be tried with different types of soil.

S. P. R.

Lysine Content of Foodstuff

Osborne and Mendel demonstrated conclusively that lysine was an essential amino-acid for normal growth and that the nutritive values of a number of proteins were closely related to their lysine contents. Morris and Wright found that a deficiency of lysine or tryptophane in the rations of milking cows lead to a marked reduction in milk yield. Estimation of lysine by the Van Slyke nitrogen distribution method is very unsatisfactory. The isolation method of Kossel and Kutcher as modified by Vickery and Leavenworth is better but requires large amounts of material. This method, modified by Block (*J. Biol. Chem. 106*, 457) may be applied to small quantities of protein but this method is also unsuitable for impure proteins.

C. A. Ayre (*Biochem. J. 32*, 1152, 1938) has effected further modification in Block's method resulting in gain in time and saving of labour. The method when applied to a food containing a low percentage of lysine (wheat gluten) was not successful due to the very high percentage of proline in the stuff.

—*H. N. B.*

UNIVERSITY AND ACADEMY NEWS

National Academy of Sciences, India

An ordinary monthly meeting of the National Academy of Sciences, India, was held on April 29, 1938, in the Physics Lecture Theatre, Muir College Buildings, Allahabad, with Prof. D. R. Bhattacharya in the chair.

The following papers were taken as read:

1. "Studies on the trematode parasites of fishes. A new trematode *Nizamia Hyderabadia* N. Gen., N. Sp. from the intestine of a fresh water fish, *Ophiocephalus* punctatus," by J. Dayal, Esq., M.Sc., Zoology Department, Lucknow University, Lucknow.

2. "Caustic Soda and Alumina from Salt and Bauxite". (A new process of manufacture), by V. S. Dubey, Y. P. Varshney and R. S. Sharma, Department of Glass Technology, Benares Hindu University, Benares.

3. "Notes on the Microscopic studies of the Igneous Rocks of Elephanta, Trombay and Salsette Islands and the Parnera Hill", by Prof. A. S. Kalapesi and R. N. Sukheswala, St. Xavier's College, Cruichshank Road, Bombay 1.

4-11. "Studies on the effect of alcohol on the metabolism of green leaves", Parts 1 to 8, by Dr U. N. Chatterji, D. Phil., National Academy of Sciences, India, Allahabad. (Communicated by Dr S. Ranjan).

12. "Chemical Examination linifolia Retz." Part 1, by Messrs Mahadeb Prasad Gupta and S. B. Dutt, Chemistry Department, Allahabad University, Allahabad.

Institution of Chemists (India)

The following are the Members of the Council for 1938-40.

President —Mr. N. N. Sen Gupta.

Vice-Presidents—Dr K. N. Bagchi; Dr Gilbert J. Fowler; Dr B. C. Guha; Dr Ali Karim; Dr H. K. Sen; Dr E. Spencer; and Dr T. S. Wheeler.

Hony. Treasurer —Mr K. B. Sen.

Hony. Secretaries Dr N. Ghatak; and Mr S. N. Sinha.

Members Mr Ronald Alcock; Dr C. Barat; Mr J. R. H. Bartlet; Mr N. K. Chatterji; Mr P. K. Das Gupta; Mr B. B. Dhavale; Dr D. R. Dhingra; Mr D. S. Naidu; Mr N. Sen; and Mr H. King.

An ordinary meeting of the Institution of Chemists (India) was held on Thursday, the 14th July, in the Chemical Lecture Theatre, University College of Science, Calcutta, with Mr. N. N. Sen Gupta, M.Sc., A.I.C., the President, in the chair. The following paper was read and discussed:-

"Studies on main principles and electro chemical observations involved in a dry cell" by Mr P. B. Sarkar, M.Sc.

A visit of the members of the Institution of Chemists (India) to the Factory of Messrs. the Bata Shoe Co., Ltd., at Batanagar, was arranged on Thursday, the 18th August 1938.

Dr Gilbert J. Fowler, delivered a lecture on "Research and Investigation" at an ordinary meeting of the Institution of Chemists (India) on the 21st August, 1938.

UNIVERSITY AND ACADEMY NEWS

Calcutta Medical Club

The following clinical meetings were held under the auspices of the Club during August 1938.

Friday, August, 12, 1938, at 7-30 p.m.

Subject: Intestinal amebiasis: its clinical manifestations.

Speaker: Dr Prebodh Kumar Banerjee, M.B.

Friday, August 19, 1938, at 7-30 p.m.

Subject: Fracture spine and its treatment.

Speaker: Dr Provat Chandra Sanyal, M.B. (Cal.) F.R.C.S. (Eng.).

Friday, August 26, 1938, at 7-30 p.m.

Subject: Mental diseases in general practice.

Speaker: Dr Sudhindra Nath Banerjee, B.Sc., M.B. (Cal.) D.P.H. (Lond.).

The National Institute of Sciences, India:

The Ninth Ordinary General Meeting of the National Institute of Sciences of India, was held on Satuday, the 20th August, 1938 at the Royal Asiatic Soeity of Bengal, Calcutta.

The following papers were read and discussed:

1. Notes on Vredenburgite (with Devadite), and on Sitaparite by Sir L. L. Fermor.

2. The Role of Nitrogen componnds in the fermentation of Fruit Juices by N. N. Chopra.

3. Bio-chemical Investigation of the Tuberculation of Water Pipes by S. C. Pillai.

4. On the Ionisation of the Upper Atmosphere by M. N. Saha and R. N. Rai.

5. Levi Civita's formulae for two bodies by Sir S. M. Sulaiman.

At the Council Meeting held on the 19th August, the following were nominated to be Honorary Fellows of the Institute.

1. Sir Arthur Eddington, D.Sc., LL.D., F.R.S., Plumian Professor of Astronomy and Experimental Philosophy, Cambridge University.

A life-sketch of Sir Arthur Eddington was published in SCIENCE AND CULTURE, January, 1938. Recently he was been decorated with an Order of Merit.

2. Prof. R. A. Fisher, Sc.D., F.R.S., Galton Professor in the University of London.

Prof. Fisher was awarded the Weldon Medal of the Royal Society in 1929. Apart for his great distinction as a scientist, his influence has been the most powerful in recent developments in connection with agricultural field trials in India. In fact the Fisherian technique has led to a great progress in Indian agriculture.

3. Prof. J. Perrin, Sorbonne, Paris.

Prof. Perrin is one of the most eminent French scientists, wellknown for his work on the sign of the charge of the electron, (1895) and on Brownian movement on which a Nobel prize was awarded.

4. Sir John Russell, D.Sc., F.R.S., Director, Rothamsted Agricultural Experimental Station, Harpenden, Herts., England.

Sir John Russell is an eminent scientist and the leading soil scientist in the United Kingdom. He visited India for about six months in 1936-37 at the request of the Imperial Council of Agricultural Research and furnished a most valuable report on the future development of Agricultural Research in India.

Book Review

Hints on Museum Education, *by J. C. Basak. pp. 1-282 (1938).*

It is very difficult to review a work which deals with subjects quite alien to what one would expect from its title; such unfortunately is the case with the work under review. From the title " Hints on Museum Education " one would expect a guide for museum authorities, such as museum curators and others responsible for the management of museums, regarding the methods to be adopted for making museums serve for the advancement of knowledge, but this is exactly what is wanting. In an introductory chapter the author deals with the importance of educational museums, but his method of treatment is very subjective, and so many subjects are mixed up in the short compass of 14 pages that the main issue becomes almost shrouded in details that have little to do with museum education. In a second chapter under the heading " Preliminary Remarks " are discussed such diverse subjects as the Spread of Museum Knowledge, Useful *versus* Ornamental Knowledge, Well-directed Education, Memory not to be taxed Improperly, Instances of Useful Knowledge, Study of Arts and Sciences and Exhibits of the Three Kingdoms, General Knowledge of Technical Subjects with sub headings ' Botany ' and ' Zoology ', Mental Hygiene and Child Psychology, Curious or Wrong Notions about Educational Museums, Mass Education in the Indian States, Children's Museums, and Properties of Objects as perceived by the Five Sense Organs. The variety of subjects treated in this chapter makes one wonder what the author's conception of the functions of a museum is. No one denies the great service rendered to education by educational museums and exhibitions of industrial objects in science museums, but the author devotes a page or o to museum work and several pages to defective curricula of educational institutions, instances of useful *versus* useless knowledge, the importance of the study of arts and sciences, etc. In fact the work appears to be based on such an imperfect acquaintance with the work of museums either in Europe and America or even in India that it is very doubtful whether his analysis would serve any useful purpose. The major part of the book (pp. 57-270) is devoted to classification of exhibits under headings like Foods, Ordinary Drugs, Medical Appliances, Houses and Architecture, Stamps and Coins, Mechanics and Machines, Arts and Manufactures, Physics, Electricity, Some Mysterious Sciences, School Exhibits, Pictures, Nativities, Horoscopes, Useful and Interesting Information, Museum Library, Children's Museums, etc., arranged in 34 chapters. These accounts are useful compendia of a heterogeneous mass of information on very varied subjects, but their utility for museum education is very doubtful. As an instance may be noted the fact that whereas some 98 pages are devoted to a description of the properties of ordinary foods and drugs, less than half a page deals with objects that should be exhibited in the Food section, and not a word about Drug exhibits. In a final chapter under the heading " Suggestions for Reformation " the author discusses certain recommendations of the representatives of the Museums Association as laid down in their report on the " Museums of India " and offers suggestions for the improvement of the Indian museums. One of these is to transform the National museum of India, the Indian Museum, Calcutta, into what he considers to be an urgent need of the country, *viz.*, a science museum, a technical museum, a public health museum, a children's museum and everything else in museum line all combined into one; such an octopus, the exact funtions of which the author has not set forth, has not been possible either in Europe or America,

and one cannot understand how such an institution could ever be estabilished in India with the very meagre funds that are available for museums in this country. Even if established, the incubus of such a gigantic institution is sure to stultify the main purposes which it is expected to serve.

—*B. P.*

INDUSTRIAL AND NEWS EDITION OF THE JOURNAL OF THE INDIAN CHEMICAL SOCIETY, *Super Royal 8vo. pp. 82, price Rs 3/- for single issue.*

The present issue constitutes the joint first and second numbers of the quarterly publications under the joint auspices of the Indian Chemical Society and the Institution of Chemists (India).

It contains original papers on (1) Bleaching of lac—from Indian Lac Research Institute, Ranchi; (2) Commercial possibilities of a new detergent -from Indian Forest Research Institute, Dehra Dun; (3) A short note on photo-electric colorimeter for the estimation of absorption of dye—from the Technological Laboratory of the Indian Central Cotton Committee, Bombay; (4) The distinction between oxy-cellulose and hydrocellulose—from the Laboratory of Chemical Technology of Bombay University: (5) Indian Coals for the manufacture of white Portland cement—from the same laboratory; (6) Studies on Indian Coals, Proximate composition and low temperature carbonisation—from the Technological Laboratory of the University College of Science, Calcutta; (7) By-products of Citrus fruits—from Government Industrial Laboratory, Lahore. In addition to the seven original contributions, the issue contains thoughtful articles on "Mineral element in Nutrition" by Dr U. P. Basu of Bengal Immunity and "Chemistry and Development of Industries in India" by Dr K. G. Naik, Government Industrial Chemist, Baroda. The inclusion of industrial research notes collected from foreign periodicals, notes of scientific interest and extracts from the Indian patent literature has made the publication useful and attractive.

A publication of this type will disseminate industrial and scientific news, and bring about contact among the chemists and the industrialists and will thus go a great way in promoting chemical industries in India. It has thus removed a long-felt want.

The organisers of this publication are to be congratulated for this excellent specimen of the first number. The get up and printing of the journal leaves nothing to be desired. It has been offered to the Fellows and Subscribers of the Journal of the Indian Chemical Society at a concession rate of Re 1/- and Rs 2/- respectively.

—*G. B.*

LETTERS TO THE EDITOR

[The Editor is not responsible for the views expressed in the letters.]

Effect of Light Rays on the Physical Properties of Protein Solutions

Proteins, as a rule, are changed by the action of light. The main function of the light is not only to bring about a physical change in it but also to affect therapeutic properties of the protein solutions. In order to study the reasons of gel-formation and gradual deterioration of anti-toxic serum in light, different protein solutions were exposed to diffused light, open sun-light and ultra-violet light respectively.

We have noticed that in sera (anti-toxic, anti-bacterial or normal horse serum) there is a gradual change in colour, relative viscosity and *p*H. But no such change was observed in toxiod solutions. In the diffused light changes take place very slowly, and the exposed sun-light of June (containing maximum ultraviolet rays), the rate is a bit rapid, but the sharpest changes were noticed in unfiltered ultraviolet rays from a mercury lamp. This gradual change of *p*H towards acid region is observed in all the sera but not in toxiod. The diffused and open sun-light favours the formation of sediments in sera, while ultra-violet rays cause gel formation due to the greater intensity of the actinic rays. It is noteworthy that, though the total protein before and after the exposure to light remains the same, still the amount of total globulin in the sera gradually increases at the cost of albumin portion of the sera, so that the behaviour of sera, towards ammonium sulphate is erratic. The results of a typical experiment are given below:

Original Serum		Irradiated Serum		Sun-light exposed Serum.
		(1 hr.)		(8 hr.)
Globulin—10.37%	..	11.1%	..	10.7%
Albumin—3.8%	..	3.1%	..	3.5%

It is interesting also that the fall of titre per c.c. was abrupt in anti-toxic and anti-bacterial sera, but in case of toxiod no change in flocculative unit was observed. Further work is in progress and the paper will be communicated in due course.

Bengal Immunity Laboratory,
Calcutta.

N. K. Roy Chowdhury.

Floods and Prediction of Flood Levels by River Models

Now that we hear and read in newspapers every day tales of devastating floods in different parts of the country it may be of more than scientific to know that it is possible to predict with a fair degree of accuracy the highest water levels that a river in spate can reach. It will at once be apparent that even if this much of knowledge could be had about the seemingly erratic behaviour of alluvial rivers in flood it will be a great gain. If it is possible to say to what level water in a river will rise when a certain flood will pass a certain point of the river, people in the neighbourhood might be given notice in time and much loss of life and property may be avoided. Apart from this if it is also possible to train a river in such a way from experience gathered from model experiments that the highest flood levels may be reduced by a couple of feet or more, it will mean, as every body who is engaged in flood relief work knows, life or death to thousands of people. It is desired here to describe some experiments that have been recently carried out by the author in connection with Emerson Barrage Project of the Punjab Irrigation.

When it was decided to build a barrage across the river Chenab to divert from its main-course the waters of both the rivers Jhelum and Chenab over a weir it was feared that the river levels upstream of the bund will go up and consequently inundate the villages in the Khadir of the rivers. Accordingly protective bunds had to be raised for miles and miles upstream of the weir on both sides of the rivers. It was desired to know to what minimum heights these bunds should be raised so that the river may not spill over even in the highest flood that has ever occurred in this river. This information was urgently required as it not only meant the saving of lives of thousands of men and of property but it gave valuable information during the period of construction. As the period of construction generally takes two to three years and the weir is built across one of the arms of the river through which water flows in summer months a ring-bund is generally put round the area in which the work of construction goes on. It is very important to know to what minimum height this ring bund should be put up so that the river may not spill over into the area enclosed by the bund.

To gain these points of information and also those about the shape and position of the guide banks, leading cuts

upstream and downstream of the weir, a model of the river was made. Details of this model are given in a publication of the Punjab Irrigation Research Institute. Here I shall not refer to all the important information obtained from this model but only mention those results that are of immediate interest to us.

A model of the river for a stretch of 6 to 7 miles was built in June 1937 to suitable scales--this included about 3 to 4 miles of the river upstream of the weir site and 3 miles downstream of the same point. A series of preliminary experiments were necessary to fix the scales of the model so that the model could be made to reproduce the conditions of the prototype. After it was proved that the model could reproduce the known conditions of the river it was used to predict conditions that were likely to occur in future. For this purpose the river in the model was surrounded by a ring-bund and discharge for the worst known year (1929) for this river was run month by month. This reproduced the conditions of the river that were likely to occur in 1938, if 1929 floods repeated themselves. River levels were continuously recorded at many important points in the river.

Since the above experiment was completed construction of the Emerson Barrage has started. The river had been bunded by a ring bund and forced to flow through its right hand channel only. During this period the following gauges had been observed at the Trimmu Boat Bridge Gauge Site. The following table gives the discharges and gauges in the prototype and in the model.

Comparision of Trimmu Gauges for the Floods of 1938 and the Corresponding Discharges in the Model for the Prediversion Runs.

Date.	Discharge.	Trimmu Gauge. Prototype.	Model.
8-7-38	85,588 cu/sec	486·2 R.L.	485·6 R.L.
28-6-38	133,433 ,,	487·19 ,,	487·0 ,,
18-5-38	150,665 ,,	488·7 ,,	488·0 ,,
17-6-38	105,917 ,,	487·4 ,,	487·5 ,,
13-6-38	187,809 ,,	488·4 ,,	488·3 ,,
26-7-38	300,000 ,,	489·5 ,,	489·7 ,,

Irrigation Research Laboratory,
Lahore.
20-8-1938.

N. K. Bose

Theoretical Interpretation of the Variation of Electrical Constants of Soil with Moisture Content, Temperature and Frequency

It has been found by various investigators 1,2,3,4 that the dielectric constant and conductivity of the soil vary with the moisture content, the frequency of the impressed waves and the temperature. The nature of the variation of the above constants with frequency has been explained by White[5] by applying Debye's dipole theory but little has been said about the mode of the variation with moisture content and temperature. In this note the variation of the constants with moisture content, temperature and also frequency has been explained by applying the theory of Wagner[6] which is a modification of Maxwell's theory. Wagner-Maxwell model when the conducting particles are spheres sparsely distributed throughout a material of low dielectric loss has been applied in the case of moist soil. The variations of the above constants have been found out experimentally also, and it has been observed that the nature of variation agrees fairly closely with that obtained by this theory.

The generalized dielectric constant for a conducting dielectric is given by the wellknown equation with the usual notations

$$k = k' - i\,k'' \quad . \quad . \quad . \quad . \quad (1)$$

and the equivalent a.c. conductivity is given by

$$\sigma = \frac{Wk''}{4\Pi} \quad . \quad . \quad . \quad . \quad (2)$$

It has been shown by Wagner that the real component of the dielectric constant can be given by

$$k' = k_\infty \left(1 + \frac{h}{1 + W^2T^2}\right) \quad . \quad . \quad (3)$$

and the imaginary component is given by

$$k'' = k_\infty \frac{hWT}{1 + W^2T^2} \quad . \quad (4)$$

where $$K_\infty = K_1 \left[1 + \frac{3r(k_2 - k_1)}{2k_1 + k_2}\right]$$

$$h = \frac{9rk_1}{2k_1 + k_2}$$

and $$T = \frac{\ }{2k_1 + k_2}$$

where K^1 and K^2 are the dielectric constants of the dry soil and water respectively,

c the d.c. conductivity of the medium in e.s.u.,
r the moisture content by volume,
h the absorption constant, and
T the relaxation time of the moist soil.

Substituting the values of K'' in equation (2) we obtain

$$\sigma = \frac{W^2T}{1 + W^2T^2} \cdot \frac{k_\infty h}{4\Pi}$$

and substituting the values of K_∞ and h in the above equation we get

$$\sigma = \frac{9k_1^2}{4\Pi(2k_1 + k_2)^2} \cdot \frac{W^2T}{1 + W^2T^2} \left\{ (2k_1 + k_2)r + (k_2 - k_1)3r^2 \right\} \quad . \quad (5)$$

Similarly by substituting the values of K_∞, h, in the equation (3) we get

$$K^1 = K_1 + \left\{ \frac{3k_1 + (k_2 - k_1)}{2k_1 + k_2} + \frac{9k_1^2}{(2k_1 + k_2)(1 + W^2T^2)} \right\} r + \left\{ \frac{27k_1^2(k_2 - k_1)}{(2k_1 + k_2)_2(1 + W^2T^2)} \right\} r^2 \quad . \quad . \quad . \quad (6)$$

LETTERS TO THE EDITOR

Equations (5) and (6) show the nature of the variations of the conductivity and the dielectric constant respectively with the moisture content, relaxation time, and frequency.

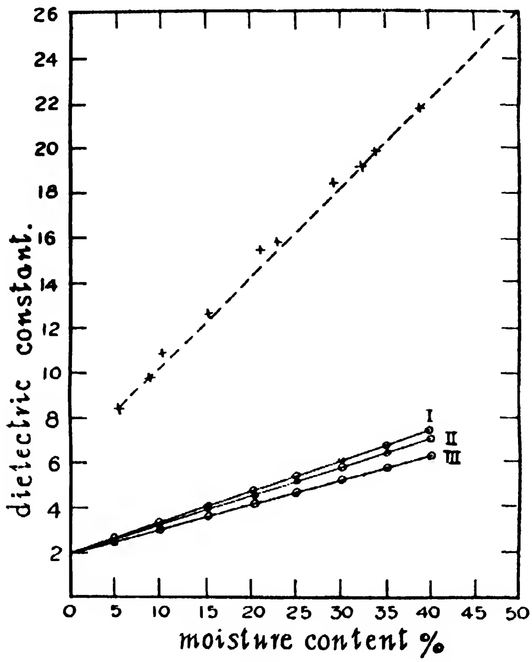

Fig. 1

The curves in figs. 1 and 2 show the variation of the above constants as obtained experimentally and also by the above theory. For the sake of convenience three cases have been considered, *viz.*, $w = \propto 0$, $w = \frac{1}{T}$ $w - \infty$. The continuous curves in fig. 1 have been drawn from equation (6) by substituting arbitrary values of the constants K_1, K_2 and T (*viz.*, $K^1 = 2$, $K' = 80$ and $T = 10^{-3}$ Sec.) The curves I, II and III represent the values at the above values of w respectively. In fig. 2 curves I had II represent the values of conductivity calculated from equation (5) by substituting the above constants at $w = \infty$ and $w = \frac{1}{T}$ respectively. The value of the conductivity at $W = 0$ will vanish. The dotted curves in figs. 1 and 2 have been drawn from the experimental values obtained at a frequency of 1000 Kc/Sec. (which is nearly the frequency as that of $w = \frac{1}{T}$) by the resonance method previously used by the author[4]. It can be seen that the nature of the variations of the constants with the moisture content is the same as those obtained from the theory. If the constants involved in the two equations be evaluated the theoretical curves will agree more closely with the experimental ones. It will be observed from the continuous curves that the change of conductivity and dielectrin constant due to frequency is more pronounced at higher percentage of moisture than at lower one which has been also practically observed by Smith Rose.[1]

The nature of the variation of the electric constants of soil with temperature can also be explained from equations (5) and (6) as the relaxation time involved in the equations will vary with temperature as has been shown by Whitehead.[7]

As regards the change of the constants with frequency according to this theory it is found that the variation is of the same form as obtained by White[5] and the variation with temperature resembles the form obtained by the author shown in a previous communication.[4]

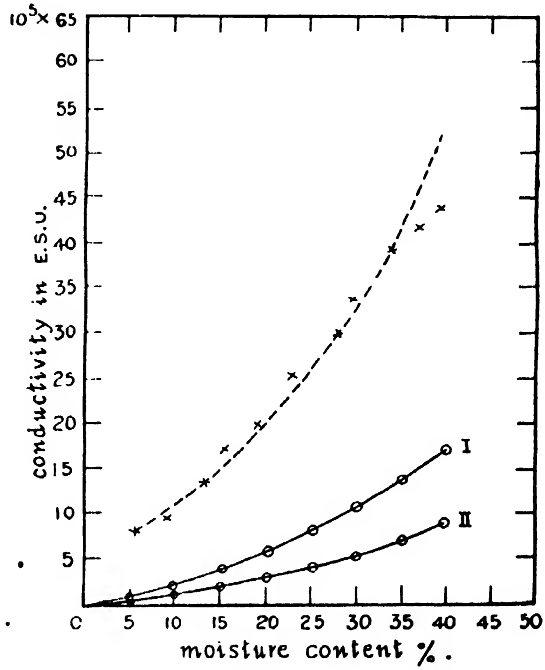

Fig. II

The author has great pleasure in thanking Prof. P. Dutt, M.A., (Cantab) and Dr S. S. Banerjee for their kind interest and suggestions during the progress of the work.

Physics Department, R. D. Joshi.
Benares Hindu University
22-7-1938.

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LETTERS TO THE EDITOR

Destruction of the Neurotoxin of Cobra (Naja Naja) and Dabola (*Vipera Russelli*) Venom by various Reducing Agents

The action of solutions of cysteine and sodium bisulphite on the neurotoxin of Naja flava venom has been recently investigated by Micheel and co-workers[1]. They have found that sodium bisulphite destroys the toxicity of venom.

Recently Micheel and co-workers have observed that sodium bisulphite destroys the neurotoxin present in the crude as well as in the purified venom in a few hours. They have also found that cysteine even in large excess can destroy only 25% of the neurotoxin present in the purified venom. The neurotoxin in the crude venom is not appreciably affected by cysteine. Slotta and co-workers[2] (1938) have tried the effect of cysteine, sodium bisulphite on the venoms of crotalus t terrificus and Bothrops jararaca and have noticed very marked destruction of their toxicity by these reagents. Micheel *et al* assumes that a thiolactone ring is present in the neurotoxin and sodium bisulphite causes in activation by breaking down the thiolactone ring. Slotta and co-workers on the other hand think that the neurotoxin contains cystine in its molecule and inactivation is caused by the sodium bisulphite by attacking the S-S linkage and breaking it into a thiol and thio-sulphonic acid. We would like to point out in this connection that the action of sodium bisulphite can also be explained by assuming that it forms an additive compound with the aldehyde or ketonic groups which might be present in the neurotoxin investigated. The effect of a number of reducing agents on the venoms of cobra and Russell's viper was tried and the results are recorded in table I.

It may be noticed from the data recorded in table I that the neurotoxin of Russell's viper venom is far more susceptible than the neurotoxin of cobra venom to the action of all the reducing agents used. It may be mentioned that control experiments with solutions of cobra or Russell's viper venom showed no appreciable loss in activity. The sodium bisulphite when added in small quantities to the solution of Russell's viper venom was found to attack and destroy the neurotoxin first. This suggests a method of obtaining the blood coagulating principle in a condition free from the neurotoxin. Further work is in progress.

TABLE I

Reagents used.	Destruction of the neurotoxin of cobra venom. Crude.	Purified.	Destruction of the neurotoxin of Russell's viper venom.
Sodium Bisulphite:			
1. 2 times the wt. of venom *p*H 5·3	80% in 5 hrs.	....	94% in 5 hrs.
2. 20 times the wt. of venom *p*H 5·0	....	85% in 5 hrs.	....
Cysteine:			
1. 20 times the wt. of venom *p*H 7·6	7% in 24 hrs.	....	68% in 5 hrs.
2. 200 times the wt. of venom *p*H 7·6	....	30%	....
Ascorbic Acid:			
1. 20 times the wt. of venom *p*H 7·6	*Nil*	....	72% in 5 hrs.
2. 200 times the wt. of venom *p*H 7·6	....	30% in 24 hrs.	....
Sulphuretted Hydrogen:			
Passed for 15 mins.	*Nil*	*Nil*	85% in 15 min.
Sodium Sulphite:			
2 times *p*H 8·0	10% in 24 hrs	....	77% in 5 hrs.
Hydrochloride Acid & Zn:	38% in 24 hrs.	40% in 24 hrs.	....

Applied Chemistry Department,
University College of
Science & Technology,
Calcutta.
20-8-38

B. N. Ghosh,
S. S. De,
D. N. Chowdhury.

[1] Micheel, *Zeitschrift fur Physiologische Chemie 249*, p. 157.
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SCIENCE AND CULTURE

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A Monthly Journal of Natural and Cultural Sciences

On a National Scheme of Education

A Chinese philosopher, Liang Ch'i-Ch'ao, defines in very pointed language the object of education as follows: "Education is the means by which the state nurtures its own kind of people, welding them together as a whole that they may be independent and struggle to strive in the world where victory goes to the *fit*, and defeat to the *unfit*". We may judge from this point of view the Wardha Scheme of primary education a short account of which is given in this journal by Prof. Nripendra Chandra Banerji, at one time professor of English Literature in the Presidency College, Bengal, and who now as a Congress worker has acquired an intimate knowledge of the village as well as of the city. A perusal of Prof. Banerji's review will show that the society which the new system of education seeks to create is one of peasants and small artisans who will be inspired by the Tolstoyan ideal of service and of Christian virtues. The education will be imparted through basic crafts– spinning and Khadi --and with the aid of day to day experience of life. The adoption of a common Hindusthani language as the second language will further enable people of different regions to understand each other quickly and without difficulty.

The basic principles of education which the Congress follows has been formulated long ago by John Dewey, the educational philosopher of America, and applied with remarkable success in the remodelling of the American system of primary and secondary education. But while Dewey's system aims at creating a society in which the average individual will be enabled to be familiar with the technicalities of the present system of mechanical civilisation, and at adult life will find himself perfectly at home with its ways which appears so bewildering to Indian leaders, the Mahatmaji who inspires the new scheme will have nothing to do with the demon of Machine. After assuring the country of the emergence of a perfect society and everyone of a living wages, and the right to freedom, the Mahatmaji expresses himself against the machine and the society produced by the machine in no uncertain language:

"And all this would be accomplished without the horrors of a bloody class war or a colossal capital expenditure such as would be involved in the mechanisation of a vast continent like India. Nor would it entail a helpless dependence on foreign imported machinery or technical skill. Lastly, by obviating the necessity for highly specialised talent, it would place the destiny of the masses, as it were, in their own hands."

Even an ardent admirer and follower of the Mahatma like Prof. Banerji finds it difficult to support him in his denunciation of the machine, and of the machine age; if we apply the test of the Chinese philosopher, the system of education advocated by the Committee will not make Indians fit for the present age.

To us, scientists, it appears that the Mahatma's system lacks in progressive vision, *i.e.*, it does not say how villages are to be linked to the cities, and how the industries which are indispensable for the Nation's life and for the body politic (those connected with transport, communication, power, essential chemicals etc.) are ever to be managed by Indians for the benefit of the Indian population. Apart from adopting a policy of *laissez faire* to these urgent problems, his whole attitude towards the machine and the modern city-civilisation is one of *defeatism*. He looks at its evils, but does not try to understand its mechanism of work and he starts with the inner conviction that the machine civilisation must be intrinsically evil. But may we submit that it is a wrong reading of history to say that the mechanisation of a vast continent like India would necessarily entail a bloody class war, or colossal expenditure, foreign experts, or foreign machinery.

It is true that the Industrial Revolution in Europe caused great social dislocation and political unrest, but this was due to that fact that the discoveries of science were first utilized by capitalists, for the sake of private gain, and statesmen and leaders of thought were slow to realize their repercussion on society and at first adopted a policy of *laissez faire* towards them just as the Mahatmaji proposes to do now and expressed itself in class war and sometimes popular discontent. When the problems could no longer be avoided and they had to introduce beneficient but contentious legislation in order to achieve social welfare. But it is the test of statesmanship to learn from lessons of history: there is the example of Europe's apt pupil, Japan, which has introduced the Industrial Revolution *without the horrors of a class war* or without having to borrow foreign technicians or foreign capital*. What has been achieved by Japan can also be achieved in India povided the Nation *will* so. It would be a happy day for India if the Mahatma can overcome his attitude of defeatism towards the Machine, devote a little time to the mastery of the technique of modern civilisation, and then makes up his mind. We are quite sure that he will find that the machine, instead of being man's master can also be made his slave, and that it is possible to utilize the machine for promoting social welfare much more efficiently than with the system advocated by him. He can then lead the Nation to the right track with his usual energy of conviction and driving power. Otherwise we feel, that by diverting the attention of the Nation from the only path which holds out prospects of relief against the present problems of poverty, unemployment and defencelessness, he will be committing what we may describe by the oft quoted phrase as a "Himalayan Blunder."

* Our appreciation of the achievements of Japan has nothing to do with her aggressive policy towards China which we unreservedly condemn.

A Review of the Wardha Scheme of Primary Education

Nripendra Chandra Banerji

THE proceedings of the Wardha Education Conference supplemented by the Zakir Husain Committee Report and the syllabus and prefaced by Mahatma Gandhi's articles in the *Harijan* on the basic principles of the New Education are very interesting reading.

In the words of Sj. Kishorilal Mashruwala, (one of the members of Zakir Husain Committee which have elaborated with a precision and assiduity worthy of all praise the details of this New Education) the Segaon Method (or the Wardha Method) is the application of the law of non-violence in the training of the child as a prospective citizen of the world; further, the centre of the Method lies in a productive industry; and yet further: the method may be shortly summed up in the phrase, "From the hand and senses to the brain and the heart, and from the school to the society and God." The sources of knowledge in this method are "work, observation, experience, experiment, service and love" and mere literacy (that is information on various matters through reading and writing) is not considered knowledge or even the medium of knowledge.

In the words of Sj. Mashruwala 'The Basic Course should include a good knowledge of the mother-tongue, a fair acquaintance with its literature, a working knowledge of the *national* language of India, a general knowledge of such subjects as mathematics, history, geography, physical and social sciences, drawing, music, drill, sports, gymnastics etc., as well as of a vocation to a degree which should enable an average student to start a modest career and a zealous and bright student, if he will, to take up a course of higher general or vocational training.' It should extend to not less than seven years.

The method has been worked out *mainly for the Basic Education through the Khadi industry,* which is the only industry in India in which the state could employ practically an unlimited number of workers without loss to itself and pay them the minimum wage necessary for healthy subsistance (not less than *one anna per hour* for work at the average speed); the schools under the system are expected to provide a major part of the running expenses by the sale of school products taken in hand by the state itself.

To quote Mahatma Gandhi himself:—"My *plan* to impart *Primary Education through the medium of village handicrafts* like spinning and carding, etc., is conceived as the *spear head of a silent social revolution fraught with the most far-reaching consequences* (the italics are ours). It will provide a healthy and moral basis of relationship between the city and the village and thus go a long way towards eradicating some of the worst evils of the present social insecurity and poisoned relationship between the classes. It will check the progressive decay of our villages and lay the foundation of a juster social order in which there is no unnatural division between the 'haves' and the 'have-nots' and *everybody is assured of a living wage and the right to freedom* (the italics are again ours). And all this would be accomplished without the horrors of a bloody class war or a colossal capital expenditure such as would be involved in the mechanisation of a vast continent like India. Nor would it entail a helpless dependence on foreign imported machinery or technical skill. Lastly, by obviating the necessity for highly specialised talent, it would place the destiny of the masses, as it were, in their own hands."

To quote (with slight adaptations) from the body of the report itself:

(*a*) Education should be imparted *through* some *craft* or *productive work which*

should provide the nucleus of all other instruction provided in the school.

(*b*) The aim is not superficial literacy but "the literacy of the whole personality—" "the important capacity of using hand and intelligence for some constructive purpose."

(*c*) Socially such education "will tend to break down the existing barriers of prejudice between manual and intellectual workers, harmful alike for both."

(*d*) Economically the scheme "will increase the productive capacity of our workers and will also enable them to utilise their leisure advantageously."

(*e*) From the strictly educational point of view, "knowledge will thus become related to life, and its various aspects will be correlated with one another."

(*f*) The object is *not* primarily the production of craftsmen able to practise some craft "mechanically" but rather the exploitation for educative purposes of the resources implicit in craft work.

(*g*) There is an ideal of citizenship inherent in the scheme- the provision of 'a minimum of education " for the intelligent exercise of the rights and duties of citizens " and for the production of 'workers' and members of "a co-operative community in which the motive of social service will dominate all the activities of children during the plastic years of childhood and youth."

(*h*) " There is an obvious danger that in the working of this scheme, which is expected to cover the major portion of its running expenses by the work of the pupils, the economic aspect may be stressed at the sacrifice of the cultural and educational objectives. Teachers may be tempted to devote most of their attention and energy to extracting the maximum amount of labour from children " while neglecting the intellectual, social and moral aspects of craft training.

The main outlines of the seven years' course of Basic Education are given in the Report as:—

(1) *The Basic Craft*:—(*a*) Spinning and weaving, (*b*) Carpentry, (*c*) Agriculture, (*d*) Fruit and vegetable gardening, (*e*) Leather work, and (*f*) other craft "regional in character" and suitable for constructive education.

(2) *Mother-tongue* (which will not only develop the capacity to write legibly, correctly and with speed, and to describe in writing every day happenings, reports of meetings in the village etc., to write personal and business letters, but insist on an acquaintance with and interest in the writings of standard authors).

(3) *Mathematics* (capacity to solve speedily the ordinary number and geometrical problems arising in connection with the craft and with home and community life; also a knowledge of business practice and book-keeping).

(4) *Social studies* (a course in history, geography, civics and current events: a simple outline of Indian history; the history of the Indian national awakening; celebrations of national festivals and of the 'National week' in the school, acquaintance with the public utility services, the working of the Panchayet and the Co-operative Society, the growth and significance of representative institutions, duties of public servants etc., a study of world geography in outline with a fuller knowledge of India and its relation with other lands).

(5) *General Science*: (*a*) Nature study: (*b*) Botany; (*c*) Zoology; (*d*) Physiology: (*e*) Hygiene; (*f*) Physical Culture (*g*) Chemistry " of air, water, acids, alkalis and salts ". (*h*) A knowledge of the stars "showing direction and time at night." (*i*) Stories of great scientists and explorers.

(6) *Drawing*.

(7) *Music* (special emphasis on group or choral singing, and

(8) *Hindusthani* (to ensure that all school children may have a reasonable acquaintance with a common 'lingua franca).'

And for the efficient working of the scheme there should be

(*a*) The proper *Training of Teachers*. They should have an understanding of the new educational and social ideology inspiring the scheme combined with an enthusiasm for working it out. The training should include a reasonable *thorough mastery of the processes and technique of certain basic crafts*. They should be trained to "link up life, learning and activity."

(*b*) *Supervision*: It should not be mere inspection, it should mean personal co operation and help offered by men "able to play the role of leaders and guides in the educational experiment".

(*c*) *Examinations*: There should be a Board of Education who should judge the efficiency of its schools by sample achievement tests, by the efficiency of the pupils in the basic handicraft and by the specific contributions made by teachers and pupils to the improvement of the general life of the community around, and lastly

(*d*) The formation of an *Independent Non-official Central Institute of Indian Education* to serve as an advisory body on and organise research on problems and policy and practice of education.

The above is a short summary of the theory and practice of the New Education which has come to be known as the Wardha Scheme of National Education (mostly in the words of the originators and of the fountain source, Mahatma Gandhi).

Now the *sociological idea of a state based on absolute non-violence* where there is no need for even a defensive national army, navy and air force, where internal order and international order will be kept by loving persuasion and kindly compromise, by the sanctions of moral force and the leverage of a cultured intelligence only is an entrancing idea; it is Gandhism at its apex. Intellectual India admires the Ideal but with very great mental reservations.

Also the *economic idea of socialisation by tacking India to a handicraft civilisation and keeping industrialisation at arm's length* to be shunned as something essentially unholy and ravenous is another of those ideas which is being increasingly rejected by Indian intellectuals, savants and scientists.

We hold to non violence as a beautifully romantic and essentially practical technique of political struggle by an unarmed nation of slaves against a fully armed police state; we do not consider it as a feasible and practical basis for a full grown, independent state.

We believe in the necessity, nay the urgency, of reviving and revitalizing, our old village industries, by new modes of harnessing of power and electricity in an increasing measure and wherever necessary. We have, however, no dread of the modern machine when it is used for social and constructive ends of production and distribution. The machine is a human product and a human product becomes evil only when it is evilly used. We do not believe India can ever become a first-class state without planned and speedy creation and socialisation of key industries.

Inspite of these beliefs, we are definitely of opinion that the Wardha scheme of Education is a very useful, interesting and efficient scheme, which if *properly* launched, after a *proper training* of a large body of intelligent, selfless and patriotic teachers, with *proper funds* supplied by the state as well as by private agencies, will after a decade or two, give us an entirely novel country-side, buzzing with hope, blazing with social service, lit up by co-operative constructive organisations. It will make the young children virile, alert and active; it will rebuild a new rural India. The education will be an education for a modest living, for citizen service, for moral and physical uplift. All honour to those who rally to this new revolutionary banner (it is revolutionary in the best sense of the term--for the idea and the method are strikingly new and adapted to the betterment of our sleepy, inert, starved villages, which are 7 lacs in number).

But at the same time, the needs of pure culture and training in the arts and sciences and industries must not be forgotten: there must be another scheme equally revolutionary to link up the village

life with the city life, to link up handicrafts with key industries, to connect the thought, the research, the poetry, the philosophy, the science of India with the world as a whole a scheme which will provide for skilled technicians, first-class scientists and thinkers and poets, able to pull their weight in the arts of offence and defence, in the sphere of Economics, Science and Letters. For it is a utopian dream to think of shunting India away from the highways of modern endeavour back to the ruts of the peaceful, contented village commune, producing its food and clothing and other simple needs and falling eventually a prey (as of old) to ravening Powers armed to the teeth with the death-dealing weapons of war, and equipped with the modern industrial and economic organisations helped by money-power and propaganda. With these reservations, we commend the Wardha scheme of Education to the general public.

Electric Power Supply in Japan 1887-1938

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Area and Population of Japan

THE total area of the Japanese Empire (excluding the recent acquisition in China, since july 1937) amounts to 681,274, Sq. Kms. and thot of Japan proper amounts to 385,000 Sq. Kms. The total population of the Japanese Empire (excluding the recent Chinese conquest since July 1937) amounts to about 10 crores and that of Japan proper amounts to 7 crores, as on the 31st Dec. 1937. The figures, statistics and data given below are all concerning the cities and towns of Japan proper. The population of Japan proper is only 5% of the world population and the area of Japan proper is about 0.5% of the world's total land area!

The density of the population of Japan proper is 181 to the Sq. Kms. being only next to Belgium, Holland and England in the order of the congestion of population, although in point of total population, Japan stands fifth, the first four, being (in order of their population,) China, India, Soviet Russia and U. S. A. Only 17% of the land in Japan is arable. Thus Japan proper tops the list in point of congestion with 1170 souls per Sq. Km. of the total farmlands. The annual increase of the population of Japan is 10 lakhs which is, roughly speaking, twice as much as those of Great Britain, Germany and France, three Great Powers, all put together. Even such a vast and rich country as the U. S. A. shows an annual increase of population amounting to only 80% of the annual increase in Japan. All these facts serve to demonstrate the tremendous pressure on the Japanese soil and the need for expansion, (conquest!) elsewhere. Being a thickly populated country and being highly industrialized, the villages are gradually merging into towns and cities. Stretches of land extending to about 20 and 30 miles, as between Kobe and Osaka, Osaka and Kyoto, or Tokyo and Yokohama are practically like one continuous street, thanks to the network of electric tramways and railways. Out of the 11, 600 cities and towns of Japan, less than 250 villages *i.e.*, less than 21 remain without electric transmission. Most of these are groups of small hamlets too far out of the way or located in some farway islets, in the inland sea.

Out of the 12, 500, 000 residential households and industrial buildings as many as 11, 4000, 000 are wired for electric purposes, apart from the innumerable advertisements of the neon lamps which even the ordinary barbers are using. This makes an average of 91% for the whole country. Even in an industrially advanced country like the United

States only 75% of such buildings are wired. The number of electric bulbs used in Japan at the end of the year 1935 amounted to 42.5 millions, that is, an average of 61 bulbs per hundred of the population. It is interesting to note in this connection that the manufacture of electric bulbs has been a great industry in Japan and at the end of the year 1934, 26 million bulbs valued at 20 million yens were produced in Japan of which 16 million bulb were exported for the value of 7.6 millions. (*i.e.*, the export rate was 2.1 dozs. per yen and 10 million dozs. were sold in the country for 12.4 millions, (*i.e.*, the sale price in the country was 0.8 dozs. per Yen). This is an instance why the prices of articles in Japan are much higher than those that are sold outside.

Japanese houses being usually made of wood (and paper, grass and bamboo!) can be wired with very little cost and trouble. In addition to this the congestion of the inhabitants caused by the crowded localities within narrow areas has facilitated easy distribution of the current. In the United States, with its vast area, nearly 25% of the houses are not yet wired.

Development of the Electric Industry in Japan

The beginning of the electric industry in Japan is supposed to date from 1878, but from a commercial point of view, the foundation of the Tokyo Dento Kabushiki Kaisha (Tokyo Electric Light Co.,) in 1883, forms the first landmark in its history. Apart from the telegraph, the first use of electricity in Japan was in 1885 in which year a cotton mill in Osaka and the Bureau of the official gazette in

TABLE No. I

ELECTRIC LIGHTING IN JAPAN (1887 1935)

Year.	No. of wired homes in millions.	No. of lamps in millions.	No. of lamps per cent of population.	Candle-power in millions.
1887	. . . .	only 75 lamps	. . . .	. . . .
1903	30,000 homes only	. . . .	. . . .	. . . .
1910	. . . .	1.95 millions	3.8%	. . . .
1913	2.2 millions	5.6 „	. . . .	52.0 millions
1914	. . . .	6.99 „	12.9%	. . . .
1919	. . . .	14.2 „	. . . .	. . . .
1921	7.0 millions	18.1 „	. . . .	. . . .
1923	. . . .	21.7 „	35.9%	334.1 millions
1926	10.2 millions	30.2 „	. . . .	548.0 „
1931	11.4 „	37.4 „	. . . .	782.3 „
1933	11.6 „	38.4 „	54.9%	810.0 „
1934	. . . .	40.5 „	59.0%	. . . .
1935	. . . .	42.5 „	61.0%	. . . .

ELECTRIC POWER SUPPLY IN JAPAN (1887-1938)

Tokyo adopted a small lighting system for their own use. In 1887, the Tokyo Electric Co., undertook to light commercially seventy five incandescent lamps using a home-made generator installed at the first commercial plant in Nihonbasti, Tokyo and capitalized at Y. 200,000. By the end of 1892, there were 11 electric power enterprises with a nominal capital of Y. 2,500,000, power generation being meant only for lighting purposes was from steam power alone.

The first hydro-electric plant in Japan was started in 1892 in connection with the Lake Biwa Canal works at Kyoto by the Kyoto Municipality. In 1895, Kyoto Electric Railway Co. was started for running electric railways. By 1898, this was increased to 2,000 H.P. by the same municipality. In 1898, the Nayoya Electric Railway Co. was started for running electric railways. In 1899, the first long-distance transmission concern was started by the Koriyama Kenshi Boseki Kaisha (Koriyama Silk Spinning Co., Ltd.) which succeeded in transmitting 10,000 volts over a distance of 15 miles. At the end of the Sino-Japanese War (1896), the number of companies increased to 47. The number of houses to which electric current was supplied in 1897 amounted to 30,000 only.

Before the Russo-Japanese War, electric power in Japan was chiefly generated from steam-plants though the water power was also used on a small scale. As the price of coal began to rise and the company's profits fell, hydro-electric power schemes were more and more taken up. Every war that Japan has fought is a landmark in its industrial development. In the year 1903, the total electric power installed was 44,000 kW. of which 31,000 was from coal and 13,000 kW. from water. Between the years 1904 to 1908, nearly 120 new companies were established. The number of lights used in 1908 was three times the number used in 1903 and the power used for electric motors increased fourfold in the meantime. The capital of the companies floated during that period of five or six years figured at Y. 227,542,000 in 1908, which was the largest sum invested in any single industry in Japan at that time. In 1907, the Tokyo Electric Light Co., constructed a long distance line from Katsuragawa and a power station of 22,500 H.P. (water volume 750 cu. ft. and height of waterfall 345 feet) at Komabashi a distance of 50 miles from Tokyo, and power was transmitted at a pressure of 50,000 volts. The electric light generated by water power was supplied 30-40% cheaper than steam electricity and on top of it was pointed out that, it was easy to make a profit 20-25% a year. This marked a new era for the Hydel scheme.

TABLE No. 2

LENGTH OF TRANSMISSION LINES

(In 1,000 Kilometres.)

	1907	1914	1928	1932
Low Voltage .	8	46	362	371
High Voltage.	9	69	406	412
Special High Voltage .	2	24	128	138
TOTAL .	19	139	896	921

N.B.—The system of *high tension* wires has spread like a spider's web in Central Japan. The highest voltage transmission in Japan at the present time is 154,000 volts and the longest distance is 150 miles of the Inawashiro Hy. Elec. Coy.

After 1904, the temporary Investigation Bureau of Hydro-Electric Power was established under the direct supervision of the Minister of Communications and investigations regarding the available water power were made throughout the country. The office was abolished on the occasion of the administrative readjustment in 1913 but the work carried out up to that time is believed to have practically ascertained the water power resources workable. Out of the 1536 places judged to admit of being utilized, at first 850 were subjected to investigation. The horse-power available was ascertained to be 2,295,223 exclusive of projects already under sanction which represented 3,275,201 H.P. The exploration and investigation cost the Government Y. 700,000 (about 10 lakhs of rupees) out of the original estimate of Y. 15,000,000 spread over five years. The office which was abolished in 1913 was resusciated in 1918 to conduct further researches on the subject. By 1921, it was shown that nearly 7,850,000 H.P. or more could be generated. As a result of the investigation and encouragement from the Bureau, the hydro-electric power quickly developed and, in 1912, had increased to 233,000 kW.

ELECTRIC POWER SUPPLY IN JAPAN (1887-1938)

whereas the thermal power amounted to 224,500 kW. only.

By 1912 production by water power had already exceeded production by thermal power. Steam and water power generations were managed independently and not as at present when steam power is employed by large companies as seasonal and supplementary power. The Great War of 1914-18 gave a new stimulus like other previous wars to the production of power and this not only increased private production but the Government directly encouraged an expansion programme of private companies by the exploitation and investigation of other water power resources. In this manner, the Government never lost an opportunity of directly and indirectly encouraging private capital to flow into this industry.

The heaviest rainfall in Japan is in the months of June and July and also in September. The average rainfall is above the average annual normal

TABLE No. 3

Electric Power Generated for Industrial Purposes in K.W.

Year.	Hydro-Electric.	Thermal.	Total.
	(In Kilo-watts)		
1903 . .	13,000	31,000	44,000
1907 . .	38,622	76,288	114,910
1912 . .	233,339	228,864	462,203
1913 . .	222,000	275,000	597,6[illegible]
1917 . .	511,090	364,474	875,563
1918 . .	597,124	386,842	983,966
1919 . .	710,929	422,314	1,133,243
1921 . .	915,000	612,000	1,527,000
1923 . .	1,307,706	755,079	2,062,785
1926 . .	1,965,970	1,236,644	3,202,614
1930 . .	2,798,000	1,602,000	4,399,000
1932 . .	3,106,000	1,827,000	4,933,000
1934 . .	3,268,834	2,223,113	5,491,947
1935 . .	3,407,997	2,638,572	6,046,569

of the world. The average rainfall in Japan is 1700 mm. a year whereas the average rainfall of the world is 800-900 mm. But Japan is unfortunate in one respect, and that is like its earthquakes which have caused her huge damage, the sudden outbursts of rainfall in the months of July are so violent that they wash off bridges, tram and railway lines, villages and cities. This year's severe and unexpected outburst of rain has not only taken a heavy toll of life but has cost Kobe (Hyogo Prefecture) alone Y. 100,000,000. The total loss in Kobe, Osaka, Tokyo, etc., has cost the Japanese Government in July 1938 over 550,060,000 yens. The month of September is also noted for its destructive typhoons. The typhoons of the year 1934 not only caused a severe loss to the power stations in Kyoto and Osaka but also totally changed the outlook of the nature of the establishments for the production of electricity. The recent typhoon of 31st August 1938 has caused a damage of Y. 10 millions.

Streams fall off in winter when consumption increases and rise high in summer when consumption decreases. Ponds, reservoirs and other provisions are made for regulation of water-resources. *Compared with other countries*, the cost of electrical energy in Japan is comparatively high beacause the earlier units (built up to 1914) are designed for illuminating purposes without regard to the cost of the unit of current generated. To-day, things are changed so much that the electro-chemical industries are supplying themselves with electrical energy (and steam also) both by thermal power at low cost in spite of the high price of coal.

The distribution of electric power is primarily in the hands of five big companies commonly known as the "Big Five". (1) Tokyo Denki, (2) Dido Power, (3) Toho Power, (4) Nippon Power and (5) Ujigawa Power which have control over all the important water resources and the principal power-consuming districts. A large number of the smaller companies are connected directly or indirectly with the above mentioned combine. The profits of the "Big Five" have been gradually increasing year by year. Profits represent above 8·9% of the paid-up capital. It should be noted that quite a number of companies have not declared any dividend and some have worked at a loss for years together. It should not be supposed that every electric company in Japan has worked at a profit.

ELECTRIC POWER SUPPLY IN JAPAN (1887-1938)

TABLE No. 4

COMPANIES CLASSIFIED BY PERCENTAGE OF THEIR DIVIDENDS (from 1912 to 1920)

Year.	Over 15%	Over 12%	Over 5%	Under 5%	No Dividends	Loss.	No. of Companies taken into account
1912 .	9	52	140	15	32	12	260
1913 .	7	75	172	20	45	20	338
1914 .	6	92	198	29	48	21	394
1915 .	11	106	197	33	60	18	425
1916 .	13	121	219	20	65	18	456
1917 .	33	118	237	9	46	20	463
1918 .	40	129	228	10	50	21	478
1919 .	58	130	230	9	47	26	500
1920 .	49	122	232	23	62	39	527

According to the statistics for 1933, the enormous sum of Y. 5,190,000,000 is invested in electrical enterprises including lighting, power, electric railways and allied industries. At the end of 1935, the paid-up capital of the "Big Five" stood at Y. 951,044,000 while fixed assets amounted to Y. 1,547,952,000.

The Tokyo Lighting Co. heads the list of power firms with a paid-up capital of Y 429,564,000 and fixed assets valued at Y 769,184,000.

A reference to the table showing the growth of electric power would show that the demand for electric power increased along with the economic expansion but it also indicates the rate of increase varied very widely according to business conditions. During the period from the Great War to 1928, the economic conditions in Japan were comparatively stabilized and this was clearly reflected in the amount of electric power consumed, the annual percentage increase ranging from 10 to 20%.

However, the percentage increase fell drastically following the temporary return to gold standard which brought a deflationary influence to bear on finances and depressed business in general. Power consumption showed an increase of 15.3% in 1929 but registered a trifling gain of only 1.4% in 1930, when the gold embargo was lifted. It was that year also in which all the electric power companies faced the problem of heavy surplus of generating capacity and resorted to reckless competition. As a consequence, in *1932, new legislation of control*

TABLE No. 5

REVENUE, EXPENDITURE AND PROFITS OF ELECTRIC INDUSTRY (1887 to 1934)

Year.	Paid-up-capital (in million Yens).	Revenue (in million Yens).	Expenditure (in million Yens).	Profit (in million Yens).	Rate of profit per cent paid up capital.	Dividend of rate per cent.
1887 . . .	(only 200,000)	Beginning	..	..	..	..
1892 . . .	2.5	Nominal value	..	..	..	..
1908 . . .	..	22.0	12.0	10.0	9.2	7.5
1922 . . .	..	439.0	251.0	188.0	12.5	7.6
1926 . . .	2,454	..	..	280.0	11.0	..
1930 . . .	3,181	897.0	641.0	256.0	8.0	7.2
1933 . . .	3,494	921.0	738.0	183.0	5.2	3.2
1935 . . .	4,125	..	..	226.0	5.5	..

Out of the total income of Y. 921,00,000, an income of Y. 277 million was derived from the supply of current made for electric lights only.

ELECTRIC POWER SUPPLY IN JAPAN (1887-1938)

TABLE No. 6

VOLUME OF POWER GENERATED AT GENERATING PLANTS

(in 1,000 kWH units)

Year.	Maximum average.	Annual percentage increase.
1923 . . .	1,152	21.2
1924 . . .	1,397	21.1
1925 . . .	1,580	13.1
1926 . . .	1,832	15.9
1927 . . .	2,090	14.1
1928 . . .	2,344	12.1
1929 . . .	2,513	7.2
1930 . . .	2,561	1.9*
1931 . . .	2,735	6.8
1932 . . .	3,073	12.4†
1933 . . .	3,324	8.1
1934 . . .	3,649	9.8

* Gold embargo was lifted.

† Suspension of the gold standard.

TABLE No. 7

TRENDS IN POWER CONSUMPTION

(in 1,000 kW units)

Year.	Consumption.	Annual percentage increase.
1924 . . .	6,572,286	32.1
1925 . . .	7,768,113	18.1
1926 . . .	9,326,390	20.1
1927 . . .	10,599,504	13.4
1928 . . .	11,914,646	12.4
1929 . . .	13,739,350	15.3
1930 . . .	13,936,188	1.4*
1931 . . .	14,144,930	1.5*
1932 . . .	15,651,210	10.6†
1933 . . .	17,403,526	11.3
1934 . . .	19,078,632	9.6

* Japan's return to the gold basis, and the acute economic distress of the nation. In 1931, there was an average surplus of 620,000 kw.

† Re-imposition of the gold export embargo.

under a competent minister was organized by the Government and the formation of the Electric Power Association by the Big Five under Government supervision stabilized all internal competition. These conditions underwent a complete change after the second suspension of the gold standard and with the general business revival due to the depreciation of the Yen, power consumption increased substantially.

TABLE No. 8

POWER CONSUMPTION FOR LIGHTING AND POWER

(in 1,000 kW units)

	1914	1928	1930	1932*
Lighting . .	159	797	888	979 (20%)
Power . .	323	2,948	3,533	3,812 (80%)
	482	3,746	4,421	4,791*

* In 1932, only 80,000 kws. (*i.e.* 2%) of the electricity were used for Agricultural purposes.

In 1933, only 1000 kW.

Total consumption, 5,000,000 kW. of which Hydro electric was 62.0% and oils and coal was 38%. The amount of coal used for the generation of electricity was about 5% of the domestic output of Coal in Japan.

In 1933, the total consumption amounted to 18,060,000,000, kWH. of which 4,000 million kWH. were used for lighting purposes and 11,700 million kWH. were used for industrial use. During the year there were 818 enterprises producing power in 7115 different plants. Amongst these were 114 municipalities in urban and rural districts producing power and managing and running their own tramways. The total income was Y. 921 millions, of which Y. 277 millions were obtained from supply of electricity for domestic purposes (lighting). The total installed power amounted to roughly 5 million kW. of which 62%, *i.e.*, 3.1 million kW. were generated by water power and 38%, *i.e.*, 1.9 million kW. was generated by steam power. The total investment was about 4,000 million yens and the working staff amounted to 170,000 souls. In 1933, Japan occupied the third place in the world in respect of production, being only next to the U. S. A.

ELECTRIC POWER SUPPLY IN JAPAN (1887-1938)

(854,000 million kWH) and Germany (25,500 kWH.). In the volume of electricity produced by water power, Japan is only surpassed by the U. S. A., Canada and Italy. Between 1912 and 1933, the development was so remarkable that the use of bulbs had increased seven-fold, the electric railway mileage had gone up seven-fold, the production of electricity had reached 8.5 times as much and the capital invested had risen to 12 times as much.

TABLE No. 9

CURRENT OUTPUT OF THE LEADING COUNTRIES OF THE WORLD in million *Kilo* watts

Country.	1929	1933
Japan . .	16,312	18,160
U. S. A. . .	90,084	82,379
Germany .	16,391	14,653
England . .	10,401	18,886
France . .	14,319	14,905
Italy . .	9,815	11,181
Canada . .	17,963	17,339
Switizerland .	3,509	3,880
Belgium . .	1,768	1,861
Holland . .	1,604	2,083

TABLE No. 10

CURRENT OUTPUT BY COUNTRIES (in milliards of kWH.)

Country.	1932	1933
Japan . .	12.56	16.96
U. S. A. . .	99.04	103.03
Germany .	23.46	25.50
Britain . .	18.71	20.30
Canada . .	15.86	17.55
France . .	13.70	14.85
Russia (U.S.S.R.)	13.39	15.86
Italy . .	10.23	11.29
Norway . .	9.15	. .
Switzerland .	4.79	4.93
Sweden . .	4.90	5.35
Belgium . .	4.11	4.26

The *per capita* consumption of electricity has been as follows:—

172 kWH. in 1927.
268 kWH. in 1933.
310 kWH. in 1934.

In England, at the same period the *per capita* consumption was said to be 600 kWH. (all produced by thermal power) and in Norway, it was said to be 1700 kWH.

Rates charged for Electricity Supplied for various purposes

Many of the municipalities in Japan have adopted a special type of street lighting which deserves to be studied. The front light on the main door outside every house in several villages and cities is connected by a special wire line and the main connection of this line in not connected with any metre but is directly under the management of the municipality. The lamp (18 C.P.) is switched on and off from sunset to sunrise and a charge of about 50 Sen (Six annas and a half in Indian money) is made monthly and is to be paid by the owner of the house. The bulbs are also coloured to indicate the profession of the owner, *e.g.*, a red bulb in the case of doctors, nurses etc. This system saves an immense amount for the municipality in street lighting, besides being a source of regular income.

Cost of the Unit

For House lamps—(16 C.P.) per bulb per house Sen 50-60 per month.

In certain factories, for the labourers during the night, in the dormitories only Sen. 15 are charged per bulb (about two annas) per month.

For factory use generally, the price ranges per unit, between Sen 2 to Sen 6 per unit (one pice to three pice).

For very large electro-chemical industries the price ranges, for large scale consumption, between 0.6 Sen to 1.5 Sen per unit (¼ pice to ¾pice).

There are special lines for supply of current in small houses where only a few lamps are required and they are charged per bulb per month.

The supply is cut off automatically early in the morning and is resumed in the evening.

(*a*) Charges in Hanshin District (Kobe) *per lamp per month* are as follows:

10 Watts or 6 Candle power ..	55 Sen. (Roughly 1 pice 2 Sen). at present.
20 Watts or 16 Candle power ..	63 Sen.
30 Watts or 24 „ „ ..	73 Sen. (nine annas).
40 Watts or 32 „ „ ..	90 Sen. (eleven annas).

(*b*) Charges in Osaka *per lamp per month* are as follows:-

8 Candle power	46 Sen.
16 „ „	50 Sen.
25 „ „	67 Sen.
40 „ „	90 Sen.
50 „ „	1.05 Sen. (1 100 Sen As 13).
80 „ „ ..	1.55 Sen.
100 Candle power	1.75 Sen.
150 „ „	2.45 Sen.
200 „ „	3.15 Sen.

For such house lighting, no charge is made for the meter as none are required. The voltage used for home lights is 100 A.C. in Osaka and 110 A.C. in Hanshin (Kobe area).

In distant areas, for home use, the price of the current goes up to 11 Sen per kW. of current consumed.

A voltage of 220 A.C. is considered dangerous, especially when the atmosphere is humid and is therefore utlized only for *power lines*. *The Alternating Current* 100 to 110 voltage has been adopted deliberately for domestic use in order to avoid accidents. It is found safe and suitable for lighting and other domestic purposes.

Electric power supplied by the electric power stations of the State Railways for the year 1933-34 amounted to 139,197,271 kWH. for which Y. 1,300,223 were spent. The net expenses per kWH. were a little more than 0.9 Sen (Y. 0.009) *i.e.*, in Indian money ½ a pice or one eighth of an anna.

TABLE No. 11

ELECTRIC RAILWAYS AND TRAMWAYS IN JAPAN

Electric Railways:		
1903		70 miles
1913		600 „
1931	over	3,625 „
Electric Tramways:		
1934	over	1,600 miles

Total Power Capacity

The total hydro-electric power reserves in Japan amount to 14.5 million H.P. (Normal flow) of which only 5.4 million H.P. are already harnessed. This makes an average of 99 H.P. to the Sq. mile as against only 20 H.P. in the United States.

The total installed plant capacity of Japan is at present in the ratio of 6 of water-power to 4 of fuel. In practice, nearly 90% of the total current output is being generated by water power. Large scale enterprises, such as paper, caustic soda, etc., generally operate their own auxiliary thermal stations equipped on an extensive scale.

In the field of hydro-electricity, there still remains a good deal of undeveloped water power which will be exploited gradually. But, on the other hand, the steam turbine which has been greatly improved in Europe since the World War is playing an important role in generating electric power, steam-pressure, formerly in the neighbourhood of 120 pounds has gradually been raised and has recently reached 1200 pounds. Electricity can thus be generated to day more economically at a steam plant than in a Hydel plant. A paper mill, for example, which needs electric power for making paper pulp has to use steam for drying paper. If electricity is generated at a low cost by high-pressure steam, the steam left over can be used advantageously at lower pressure for drying paper. Both steam and electricity are also required at plants where dye-stuffs and chemical fertilizers are made. The same is true for the manufacture of soda carbonate by the Ammonia Solvay Process. The Toyo Soda Kogyo, K.K. of Japan which manufactures both soda

carbonate and caustic soda claims that the cost of the electricity which it produces in its own power generating plant is one of the lowest in Japan. Electricity can to day be generated at a low cost even when coal is high in price. As it becomes necessary to go deeper into the mountains for water-power, the construction of hydro-electric plants become more costly than before. Water-power at one time, used to be cheap and a coal-burning plant was only an auxiliary. But conditions have changed, and to-day electricity is generated at some places by coal at much less cost than water power.

In Japan, instead of throwing away surplus power available in hydro-electric schemes in the rainy season when the supply of power is the maximum available, it is customary to use this power for chemical industries which do not have to depend upon steady power. The latest practice is to operate a water power plant at the full capacity when there is abundant supply of water and to have a steam plant as an auxiliary to operate in the low water season. This is one of the reasons why electrical enterprises have recently increased and have become profitable in Japan.

Regarding small industries and their success, the abundance of cheap electric power (as also cheap coal gas) enables small enterprises to obtain an adequate supply of motive power at low rates. Even large factories which formerly depended on steam power and later utilized the method of group drive by means of electro-motors have recently adopted individual drive extensively.

The electric industry in Japan was originally planned only for lighting purposes irrespective of the cost of production per unit. Its use was then extended to electric tramways many of which were taken up by municipalities like those of Kyoto and Nagoya. The municipalities also took the control of street-lighting in their own hands and did not leave it to foreign private companies to exploit the ready-made market. Power development for industries soon followed and the wars waged by Japan gave an impetus and opportunity to expand the industries which were being systematically subsidized and fostered by the state. The recent munition and electro-chemical industries, involving the production of aluminium, ammonium sulphate, alkalies, iron and steel, etc. have given an enormous impetus to the Japanese trade, and with the depreciated yen which is worth half its pre war value in foreign currencies, Japan hopes to *turn her electrical resources* (with Japanese raw materials whose prices have gone up only slightly) *into the form of finished merchandise*, and have a wide market abroad.

The typhoons and floods of September 1934 caused a heavy loss to the industrialists of Kyoto and Osaka. The heat power stations located within a small and limited area were one and all put out of action by the floods. None of these stations was in a position to operate for days together in place of the water-power stations which had been badly damaged. The present trend is to install Diesels within individual workshops to become self-supporting.

TABLE No. 12

Water Power of the World by Countries in 1932

(in 1,000 H.P. units)

	Total potential power during low water season.	Developed.
Japan Proper .	6,400	4,100
U.S.A. . .	38,000	14,885
Canada . .	18,000	6,125
Italy . .	3,800 (5,857 during high water season)	4,840
France . .	5,400	2,300
Germany . .	2,000 (highest developed power)	2,000
Norway . .	9,5000	1,900
Sweden . .	9,000	1 675
Spain . .	4,000	1,000
Austria . .	1,660	700
Brazil . .	15,100	640
U.S.S.R. . .	16,425	496
Mexico . .	6,000	494
England . .	850	400
Others . .	311,365	2,545
Total	446,000	46,400

TABLE No. 13

Power Consumption of Industries (in kilowatts)

Industries	1933	1934	1935
1. Chemicals	562,361	773,000	825,000
2. Textiles	516,188	552,000	574,000
3. Mining	366,278	302,000	333,000
4. Food-stuffs	291,247	311,000	320,000
5. Metal Products	258,718	501,000	676,000
6. Ceramic Products	170,478	211,000	242,000
7. Engineering	147,944	203,000	229,000
8. Lumber and Wood Products	135,497	145,000	151,000
9. Printing, Book-binding and Agriculture	..		
10. Others	785,069	176,000	177,000
		641,000	645,000
Total	3,255,735	3,818,000	4,178,000

Laws Relating to State Management of Electric Power Industry

Legislation on the electric power industry has its basis from the viewpoint of national defence and as motive power for industry in general. A previous Government drafted a bill to enforce strict official control of the generation and transmission equipment which would have reduced the existing private companies to mere distributing agencies as their principal plants were to be compulsorily taken over by a Government company. The plan was perhaps too drastic to be passed through the Diet without serious amendments.

The national emergency has again induced the present Government to come forward with a bill on the same problem. In view of the complicated and controversial character of the subject, a special committee was first formed to prepare the material for drawing up the bill. The ultimate plan was based on the majority opinion of the above committee, its characteristic being the exclusion of the already developed water power from compulsory investment, which according to the previous Tanomogi plan was included together with steam power and transmission systems. The fundamental idea of the bill was explained by the Minister as follows: "Because of the basic nature of the industry and its monopolistic character, exploitation of electric power resources should not be left to decisions based on mere profit-making or private economy".

In the Diet, the bill was subjected to poignant criticism, doubts being expressed concerning the efficacy of government-managed company and the constitutionality of compulsory investment. Difficulties were also encountered in the valuation and compensation problem of investments by private companies and how to dispose of bonds issued in foreign currencies. The bill was, however, finally passed with amendments agreed upon by joint conference of both Houses of Parliament.

Legislation comprises the following four Laws:

(1) Electric Power Control Law.

(2) Japan Electric Generation and Transmission Company Law.

(3) Debenture Disposal Law in Connection with State Management of Electricity.

(4) Amendment to Electric Power Enterprise Law.

Electric Power Control Law

The fundamental objectives of the national electric power policy is revealed at the commencement of this law: "The Government is authorized to manage the generation and transmission of electric power, in order to lower the cost of electricity, ensure an adequate supply of power and to promote a wider range of its use (Art. 1)". The practical management of the plants, however, is conferred upon the Japan Electric Generation

and Transmission company (Art. 2). A Bureau called "Electricity Bureau" will be newly established to supervise the new company, and under this bureau, practical plans for the erection of plants will be decided (Art. 3). An advisory council will be established to assist the above bureau in deciding power rates and other important problems (Art. 5).

Japan Electric Power Generation and Transmission Company Law

The Japan Electric Power Generation and Transmission Company will be established to take over all major new water and steam power equipment and all the main transmission systems. As a general principle, however, existing water-power equipment will be left as at present, but the power generated will be conveyed through the transmission system controlled by the new company.

As regards the valuation of the plants taken over, half of the total value of construction costs and profit will be considered as share of the private companies. Construction cost is defined as the cost actually paid out for construction, reduced by the amount for depreciation. The profit value will be decided in consideration of the average profit rate for the past ten years (Art. 9). The contributing companies will be paid in shares of the new power company (Art. 11). In case a contributing company cannot continue business with the plant left in its possession, it may request the new company to acquire the whole plant outright (Art. 14.).

The contributing companies may request the new company to exchange the shares given to them into cash or company bonds at face value (Art. 15).

The management of the new power company will be exercised by a President, Vice-President, five directors, and three auditors (Art. 18). The President and the Vice President will be appointed by the Government among 10 candidates elected by the general meeting (Art. 20). Ex-officials who have been supervising the company cannot become directors for five years after their resignation from Government service (Art. 22).

The new company will be previleged to increase its capital even before calling up the un-paid capital, to the extent of three times its paid-up capital. The Government guarantees a minimum dividend of 4% for ten years after the establishment of the company (Art. 32).

Debenture Disposal Law in Connection with State Management of Electricity

With the enforcement of the above-mentioned laws, a difficult problem may arise as regards the debentures of private companies issued on the security of their assets. This is especially true in connection with funded foreign borrowings. The law accordingly regulates that equipment on the security of which bonds are issued, will remain unaffected, even after the equipment is handed over to the new company (Art. 1). To profect the bond-holders' interests, the new company shall guarantee both the principal and interest, in case obligations are not met by the contributing companies (Art. 3). In case all or a larger part of the mortgaged equipment is taken over by the new company, the Government is authorised to transfer the burden of the debt to the new company (Art. 4). In such case, the company will reject repayment before maturity (Art. 7), whilst the Government will guarantee both the principal and interest (Art. 8).

Amendment to Electric Power Enterprise Law

Government control will also be strengthened as regards the retail service of electricity. Government supervision over the disposal of profits, depreciation and extension of service area is added to the original law (Art. 23). The Government is authorized to order private companies to take over or to exchange certain areas to permit lower charges (Art. 24, 26).

Bioluminescence

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By 'bioluminescence' is meant the production of light by living organisms, of which the fire-flies are the well-known examples. The production of light by these living organisms attracted the attention of people for a long time. It was also known to them that moisture is a necessary condition for the luminescence being visible. Though this subject of animal luminescence attracted the attention of chemists like Robert Boyle in the seventeenth century, nothing could be clearly stated about the mechanism of the production of light until 1885 when Dubois suggested the cause to be the enzymic oxidation which is occurring within the cells of these animals. In recent years Havery, Kunda and others made a systematic study of the subject. Thus to-day it is known that this light production is a peculiar phenomenon of enzymic oxidation in presence of a special substrate within the cell.

The phenomenon of luminescence has been observed among fire flies, glow-worms, crustacea, mollusca, and among 40 different orders of animals as well as of numerous bacteria and fungi. Thus the phosphoresence of the sea, the ghostly appearance of rotten tree stumps and the glow of meat and fish in the dark are all due to one or another bioluminescent organisms undergoing oxidation.

The luminous material is almost universally manufactured by the living cells as granules which undergo oxidation within the cell. There are two different kinds of this oxidation (*a*) intra cellular luminescence, as is the case with fire flies, (*b*) extra-cellular luminescence, *i.e.*, where luminous slimes or secretions are extruded, chiefly among *astrocod, crustacea, etc.*

Whatever may the process of oxidation the actual mode of light production is due, as has already been stated, to enzymic oxidation. Thus, inside the cell there are both the enzyme and the substrate, in the form of granules; both are distinguishable under the microscope, one large and yellow and the other small and colourless. The enzyme is known as luciferase and the substrate as luciferin. The enzymes, luciferases, of different species of animals are different and different shades of luminesce are produced when they act on luciferin of closely allied forms. No light-production is possible if luciferin of different species are used.

Luciferase and luciferin can be prepared from living animals but the dried organisms serve as a better source. Drying the organisms quickly in a vacuum desiccator over calcium chloride is best, as the dried material retains its activity for 15 years producing light whenever moistened. Thus the dried material contains both luciferase and luciferin in an unharmed condition and the phenomenon of luminescence is not a 'vital' process in the same sense as nerve conduction or muscle contraction.

From the dried material luciferase can be separated by simple cold water extraction, since contact with water and oxygen of the atmosphere brings about complete oxidation of the substrate luciferin. The process of oxidation may be hastened either by aeration or by adding substances of the type chloroform. The substrate luciferin is likewise prepared by the destruction of the enzyme. Simple hot water treatment is quite sufficient to destroy the enzymic activity without allowing time to oxidize luciferin.

Luciferase is non dialysable, and destroyed by trypsin. It is insoluble in alcohol and in all fat solvents. The enzyme can be precipitated by protein precipitating reagents like -phosphotungstic acid, etc. chemically, luciferase behaves as an albumin, but its chemical nature is yet unknown. Luciferin behaves like protein and remains stable in absence of oxygen.

BIOLUMINESCENCE

The mechanism of luminescence has been the subject of much discussion, since oxygen, rather than moisture, is a necessary accompaniment of the enzymic oxidation. Oxidizing agents like potassium ferri-cyanide in absence of oxygen failed to produce luminescence. Therefore, luciferin, luciferase and free oxygen form a triod making up the bioluminescent system. The enzyme luciferase acting in a like manner as enzymes of the type oxiedases. The chemical process underlying the production of light in aqueous media may be represented as

$$\text{luciferin} + \text{luciferase} + \tfrac{1}{2}O_2 \longrightarrow \text{oxy-luciferin} + H_2O + \text{light}$$

Thus luciferin is oxidized to oxy-luciferin. This product seems to represent a very slight change in the molecule since it can be reduced to luciferin again provided oxygen is absent during the process of reduction. No luminescence accompanies reduction. Since nascent hydrogen is a good reducer and other methods of reduction (hydrogen and Pt, or Pd, H_2S, $Na_2S_2O_4$ etc.) involve the taking up of hydrogen, we may represent the change to occur in the following manner

$$\text{oxy luciferin } (L) + H_2 \longrightarrow \text{luciferin } (LH_2)$$

Thus the process of oxidation can be represented as

$$LH_2 + \text{luciferase} + \tfrac{1}{2}O_2 \longrightarrow L + H_2O$$

Since bioluminescence is undoubtedly an example of chemiluminescence,-- a luminescence produced by the direct result of the energy of a chemical reaction and quite distinct from fluorescence or phosphorescence, where the energy for light production comes from incident radiation. Chemical luminescence may be of two kinds corresponding to two varieties of photo-chemical reactions. (i) the direct photo-chemical process in which molecules absorbing radiation (excited molecules) undergo photo-chemical change and (ii) the sensitized photo-chemical reactions in which the photo-sensitizer absorbs the energy of radiation, later transfering it by collision to other molecules, which undergo photo-chemical change. Thus, in the first type of chemiluminescence, the energy of reaction remains with the reaction product and may be emitted as light whereas in the second type mentioned, the excited molecule resulting from the reaction transfer by collision their excess of energy to other molecules, exciting them to luminescence. Thus luciferin—oxyluciferin—luciferase system is the ideal case of the latter type of chemiluminescence. Thus luciferase is the source of luminescence, since the energy produced by the oxidation of luciferin to oxyluciferin excites luciferase molecules which luminesce on being returned to their normal state. Thus the reaction is represented as follows.

(1) $\text{Luciferin} + O \xrightarrow{\text{luciferase}} \text{Oxyluciferin}' + H_2O$

(2) $\text{Oxyluciferin}' + \text{luciferase} \longrightarrow \text{Oxyluciferin} + \text{luciferase}'$

$\text{Lu} \longrightarrow \text{luciferase} + h\nu$ (3)

The process of oxidative reaction is catalysed by the enzyme present and the product of oxidation carries a quantum of energy indicated in (1) by dash. This quantum of energy is transferred to the enzyme in (2). The enzyme luciferase loses its quantum of energy as a quantum of light ($h\nu$) producing the phenomenon of luminescence (3)*

*Read at the Calcutta University Chemical Club on April 12, 1938.

The Semi-Centenary of the Lick Observatory

The Lick Observatory, California, celebrated last June its semi-centenary. At one time it ranked as the premier observatory in the world, but within comparatively recent times it has been eclipsed by other observatories, like the Mount Wilson and the Dominion Astrophysical Observatory, Victoria, Canada. But the Lick Observatory has got a splendid record of work to its credit.

The history of its foundation will prove interesting to readers of Science and Culture. The founder, James Lick, was by profession a mechanic from Pennsylvania and of Dutch stock and had very little liberal education. He migrated to Peru as a maker of pianos and made some modest fortune there. Later he migrated to California and invested his savings in real estate. Though California was known to the world as the Eldorado, the land of gold, the actual discovery of gold was made in 1849 in a rather romantic way accounts of which can be read in '*Men and Metals*'. The story of the discovery of gold caused a large influx of adventurers from all parts of America and Europe to this part of the country, which was still then mostly uninhabited. People who had already settled there and invested in real estate suddenly found themselves possessed of huge fortunes and by 1875 James Lick, a fairly old man, found himself possessed of millions of dollars and did not know what to do with them. At one time he thought that he would invest his fortune in making a large bronze statue of himself and his wife, overlooking the Sanfrancisco Bay after the manner of the classical Colossus of Rhodes. But he had joined a club of learned men some of whom came to know of this project and wanted to dissuade him from it. But James Lick had a mind of his own and he changed his opinion only when somebody pointed out that the projected statue would be at a very exposed place and that the Russians might come some day and bombard it to atoms. Somehow he was persuaded to the idea that a large telescope would be the proper thing to invest his millions in. He got a number of advisors and formed a project which after a good deal of vicissitudes grew into the Lick Observatory. The total donation to the Observatory was about 700,000 dollars but the benefaction was not sufficient to leave a surplus for the running expenses. This is generously met by the University of California.

Edward Singleton Holden, then director of the Washburn Observatory of the University of Wisconsin, was appointed the first Director of the Lick Observatory, at the recommendation of Simon Newcomb, whose assistant he had been at the U. S. Nautical Almanac Office. He resigned in 1897, retiring to private life, and was succeeded by his pupil, James Edward Keeler. The next director of the Observatory was W. W. Campbell, best-known for his application of the spectrograph to the study of stellar motions, a field in which he was a pioneer. R. G. Aitken, well known for his work on double stars, followed Aitken as director, retiring in 1935, when he was succeeded by Wright.

A word about the splendid scientific work carried out by the Lick Observatory. We all know that of the nine satellites of Jupiter four were known to Galileo; and four more were discovered here. The discovery of about 4,000 visual double stars and 400 spectroscopic binaries also goes to the credit of the Lick Observatory. Amongst its other achievements, we may mention the exact measurements of celestial spectra by Keeler, the epochal observations of double stars by Burnham, and the discovery of the dense companion to Procyon whose existence was suspected by Bessel some 75 years earlier, and of 33 comets. Besides, the members of the staff of the Lick Observatory have participated in many eclipse expeditions. A party was sent to India to observe the eclipse of January 22, 1898 and it was then that the moving-plate technique of Campbell was introduced.

A Geologist in Russia

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Geological Survey of India, Calcutta.

It is necessary to say that many of us went to the U.S.S.R. in connection with the International Geological Congress frankly sceptical of all the claims we read about the Russian Geologists, and some of us maintained a polite disbelief of these claims until they were demonstrated during actual field studies and other visits. The most convincing proof to me, after finding the Soviet geologists to be as thoroughly keen and efficient as the best among ourselves, was their complete self satisfaction. There was clearly close scrutiny among themselves of each other's work, and it was evident that no serious error of judgment or faulty deduction, on a fundamental matter, could escape notice. Their efficiency had gained for them the complete confidence of the Soviet Government, who have made great demands for supplies of mineral raw materials and had so far obtained their requirements by the usefulness of their Geological Survey.

As regards travel details, the Soviet frontier formalities are now well-known. Every bag and box is literally emptied, every handkerchief is shaken out, every book is scrutinized and newspapers usually confiscated, and then after this exhausting business they seem to forget to collect revenue on obviously dutiable articles as tobacco and brandy. By this stage the language difficulty has probably induced friendliness and you may be conducted to your train by a porter who will certainly refuse a clumsily tendered tip. It is true that it is not possible to buy, in the U.S.S.R., a first class railway ticket for travel on European railways outside the Soviet Union. This shows that there is some difference, but the Russian first class or tourist class is quite as comfortable as one desires in the conditions previling in the U.S.S.R. The same remarks apply to hotel accommodation except perhaps in the newest Moscow Hotel in the capital, which is very good. The greatest trial is the delay over meals in any hotel, until experience teaches the tourist to go to meals at off hours or to a table where the waiter values a tactfully placed tip- yes, even 50 kopeks which represent half a rouble. The present exchange is roughly 25 roubles to the £ or say a rouble equal to - 9/- annas, but in buying Russian beer at 3½ roubles or Russian cigarettes at 6 roubles for 50 we found the value of the rouble nearer 4*d*., and so, expensive.

According to the Soviet constitution every citizen is entitled to work and is paid according to ability, skill and responsibility. They have a Rest Day after every five days' work when they work roughly 8 hours a day. They are entitled to full pay leave, to free medical attendance, to free education for their children, and to old age pension besides other allowances. In the Hammer and Sickle Steel Works near Moscow where an annual output of 250,000 tons of steel products sheets, bars, rods and wire is maintained, the unskilled workmen get 200 to 400 roubles a month, the furnace foremen may earn 1,000 roubles a month, the metallurgical chemist as much as 3,000 roubles a month, and the general manager has a salary of 2,000 roubles plus a bonus on output. Women have equal rights with the men, which means of course that they have more. We saw women at work on rail-road ballasting and track work, as workers under-ground in coal mines, as tram conductors and drivers, operating machines in various types of works and invariably as clerks and accountants. All hotel and railway booking and enquiry offices are staffed with women, and almost without exception the guides and interpreters on sight-seeing tours are neatly dressed young ladies. When a particularly well dressed lady was introduced to us we knew instinctively that we were about to be asked for our impression and opinions by the journalist of some important Soviet newspaper. Women of course take an active part in educational work and as investigators in scientific research, but

we were surprised to find several women on the Russian Geological Survey who carried out the arduous duties of field work and welcomed our scrutiny of their maps and deductions. Home life, as we know it, is fast disappearing as the tendency is to live in rooms or suites and have meals in restaurants and hotels. I was very astonished at the almost entire absence of dogs in Moscow and most of the cities we visited.

From a metallurgical point of view the new steel works at Magnitogorsk in the South Urals and Kuznetsk in Siberia have pride of place. They are over 1,000 miles apart and each is said to be more than twice as big as the Tata Works at Jamshedpur and to have been erected in a shorter period in wild and useless country. Instead of each work being a centre for the assembly of raw material -iron ore, coal and limestone necessitating the return of empty wagons to the mines and quarries, these two great works are linked. Magnitogorsk has been erected near the iron ore mines while Kuznetsk is the coalfield so that the wagons taking coking coal to Magnitogorsk return to Kuznetsk with iron and thus haulage of empty wagons is avoided. Shortage of railway wagons and the extent of the Russian railway has made it essential for the Soviet Government to devise means of avoiding unnecessary rail haul. With this object in view it is becoming the practice in some colliery centres to convert large quantities of coal into gas and to pipe this gas to power stations which previously used coal. Thus large gas producers have been erected at Tula for the supply of gas for boiler firing and other purposes in Moscow nearly 100 miles away. There is thus not only a saving in the haulage of raw coal but in the avoidance of smoke in the city and the absence of any ash to handle in the power stations.

In the west Urals collieries have been opened at Kizel to work a coal not exceeding 12 feet thick, in strata tilted at a steep angle (30° to 40°), and averaging 21 per cent. ash with 5 per cent. sulphur. We would forget about such a coal almost anywhere in India, and yet it is being raised at 4,000 tons a day in a colliery which is equipped in a manner superior to anything seen in India. The coal is coked and the surplus gases used for boiler firing in a great central electrical station which supplies electricity to the colliery and the villages round and for the electrification of the railway for 400 miles. The high sulphur coke, which is useless for iron ore smelting, is utilized in an adjacent area for copper ore smelting.

The Soviet claim that reserves of copper ore estimated to contain 17 million tons of metallic copper, roughly 16 per cent. of the world total, have been established in Russia, is still considered as 'not proven' I was not able to visit the Kounrad deposits in Kazakhstan, but it is certain that the large copper smelting works on Lake Balkash are to be supplied with the Kounrad ores and the production of metallic copper at these smelters is estimated at 100,000 tons a year at full capacity. On looking into details, however, I was astonished to discover that the Kounrad ores averaged under 1.5 per cent. of copper, which is appreciably below the famous low grade copper ores of Chuquicamata in Chili which average over 2.0 per cent. copper and has the finest smelting works in South America. Our Indian copper ores of Singhbhum normally contain over 3.0 per cent. of copper although somewhat inferior ores are treated by the skill of the present management. I was given to understand that the Soviet metallurgists aimed at treating sulphide copper ores with as low as 0.75 per cent. copper.

A Russian claim which I am pleased to confirm was that of producing commercial quantities of oil from strata of Palaeozoic Age a subject somewhat painful to those engaged in the search for oil in England. At the Sterlitamak-Ishimbaevo oilfield in Bashkiria the annual production of oil from numerous deep wells was of the order of a million tons, and there was no doubt at all that the oil was coming from rocks not younger than the Lower Permian equal in age to the Lower Gondwana Coal of India. Further, the geology of the trans Volga region showed that the same rocks were present further north, and borings had proved two areas, east and west of Perm, in the Kama basin, which were potential oilfields.

The potash salt deposits, estimated at 15,000 million tons of potash, in the Solikamsk area was to my mind the best example of Soviet geological and mining enterprise. They claimed deposits of potash salt greater than those of Stassfurt in Germany and, backed by the Soviet Government,

were producing over 1,500,000 tons of potash a year. The equipment of these mines, which we descended, is absolutely up-to-date and includes an underground workshop for all repairs. The shaft is equipped with two winding engines one for hoisting skips and the other operating double-decked cages from a depth of 750 feet and raising 5,000 tons of potash salts daily.

There is to my mind no finer example of scientific skill, supported by State funds, than the development of the Russian aluminium industry. Aluminium ore had been found at Tikhvin in 1883 and re-discovered in 1916, but when carefully examined in 1925 this bauxite was considered unattractive for aluminium production. However, when the Volkhov hydro-electric station was opened in 1926 the Soviet chemists set to work to discover a means of utilizing the Tikhvin bauxite and devised a commercial process by 1929. Meanwhile the Soviet geologists had found rich alunite deposits in Azerbaijan in the Caucasus, and immense quantities of phonolite in the Khibin of the Kola Peninsula. Means were also devised for preparing alumina from these raw materials, and special success attended the recovery of alumina from the phonolite. The Soviet Government sanctioned an aluminium works at Volkhov in 1929 and when this was completed and produced 800 tons of aluminium in 1932, another large aluminium works was begun at Dneipropetrovsk near the huge hydro electric station. Those who know the complicated details of bauxite purification and the metallurgy of aluminium will know what I mean when I say the Russian aluminium industry was based on abnormal lines and was consequently economically unsound. However the production of aluminium had risen to 4,000 tons in 1933 and the Soviet chemists had secured an enormous experience in establishing a domestic aluminium industry. Then suddenly in 1933 good bauxite was discovered in the Urals in sufficient quantities to be workable on a large scale. A new reduction works was immediately begun at Kamensk near Sverdlovsk and was to have been operating at the close of 1937. The production of aluminium from the two older works had meanwhile risen as follows: 14,000 tons in 1934, 24,000 tons in 1935, and 36,000 tons in 1936. It is estimated that 72,000 tons will be produced in 1938 when the Kamensk plant is working. A fourth plant is now under construction in the north and there is little doubt that the Russian aluminium industry will shortly lead the world.

It seemed wonderful that the present great Soviet organisation for geological surveys and mineral developement has grown from the old Russian Geological Survey, which in 1913 had a cadre of 30 geologists and a budget grant of about 4 lakhs of rupees and was considered as a sort of scientific luxury. It is not too much to say that the existing Geological Survey of the Soviet Government is by far the biggest organisation of its kind and holds an unique position among similar institutions in other countries. Elaborately staffed and equipped, abundantly furnished with means, and loaded with heavy responsibilities the Russian Geological Survey has the complete confidence of the Soviet Government. Its Central Geological Administration has been made responsible for all geological work—research and surveys, as well as prospecting, development and working of mineral deposits throughout the U.S.S.R. In addition to the normal duties of advising the Soviet engineers in regard to the selection of new railway routes, canals, building sites, proposed tunnels and the foundations of dams, the Soviet geologist is consulted on all problems of road and building stone, cement making materials, and brick clays. Questions of underground water and surface water supplies, both for town supplies and for irrigation purposes, are specially referred to him, as well as other irrigation problems relating to soils and silt. Unless the Soviet geologists had abundantly proved their usefulness to a Government, who seem bent on developing their mineral resources so as to dispense with imports of such materials, they could not have been expanded and financed as they have been. They have, to some extent, been fortunate in that the mineral production has been entirely under State control for State purposes, so that no commercial competition of a serious nature has existed. However, notwithstanding some uneconomical features, the geologist in Russia has proved that the successful Soviet industrialization, which we saw, could not have been carried out within so short a time as 20 years without a properly equipped Geological Survey.

Clove Industry in India

THE Zanzibar Government, in June 1934, passed a Clove (Purchase and Exportation) Decree and organised an association called the "Clove Growers' Association" with wide powers of interference with free trade in cloves. This Decree practically resulted in squeezing out indian merchants from lawful pursuits in the Zanzibar Protectorate, and it formed the subject of much comment and criticism both in India and in Zanzibar. Organised boycott of Zanzibar cloves was carried out in India on a wide scale. The Government of India took up a sympathetic attitude towards the cause of the Zanzibar Indians. The Zanzibar Government had ultimately to yield to the Indian clove traders in respect of about 50% of their demands. It appears however that the Zanzibar Administration is more anxious to protect the interest of the Clove Growers' Association than the legitimate interests of the trade and of the Indian traders. It is therefore, in the fitness of things that attempts should be made to grow this commodity on Indian soil not only to secure the proper recognition of the rights of the Indian traders in the world's clove market, but also to make this country independent of foreign supply.

In May 1937, the Imperial Council of Agricultural Research accordingly started an inquiry on the present state of clove cultivation in India. Mr. A. K. Yagna Narayan Aiyer, retired Director of Agriculture, Mysore, was appointed special investigating officer for this purpose for a period of six months. He inspected as many clove growing localities in Southern India and in Ceylon as possible with particular reference to the conditions of soil and climate and the general features of the cultivation, growth conditions, yields, diseases etc. Also, through the help of available published literature and from information gathered through correspondence, he collected considerable data on the conditions of cultivation in other clove-growing countries, notably in the Zanzibar Protectorate and in Madagascar. The report of this investigation has recently been published by the I. C. A. R. (*Miscellaneous Bulletin No. 20*). The report describes in detail the various factors which lead to a good yield of clove in different parts of the globe; and Mr Aiyer expresses the view that the growth of clove trees in Nilgris, Tinnevally and Travancore States have the same general characteristics as elsewhere.

Clove trees are found to flourish within the tropical zone between the Tropic of Cancer and the Tropic of Capricon. So far as India is concerned, the whole of Southern India falls well within this geographical belt. The most serious difficulty for the proper growth and fruiting of clove trees under Indian conditions seems to be that although the total annual rainfall in these tracts will more than satisfy the requirements of the trees, the monthly distribution is not by any means satisfactory. Mr Aiyer points out however that "with suitable shade and, if at all possible, with some arrangement for some hand-watering of the young seedlings, the first two years can be weathered successfully. Indeed with suitable methods of plantations, we may, without undue optimism, expect to bring into existence some five lakhs of trees in the course of the next fifteen years".

The clove industry suffers seriously from the handicap that very little is known regarding the striking differences which are often observed as regards the bearing capacity of trees. The ordinary yields of eight to ten pounds of dry cloves per tree are often largely exceeded. Yields of fifty or sixty pounds per tree are not rare, and there is even a record of the phenomenal yield of 250 lbs. per tree. An accurate scientific study of these high yielding varieties is immediately necessary. The soil and moisture conditions which favour such high yields need also careful investigation.

Then again, the quality of cloves is regulated by the traditional opinion of the trade where colour, shape and size are the deciding factors. Zanzibar

quality with a clove-oil content of 17%, sells at Rs. 8'17 per 25 lbs. while the first grade Penang quality with an oil content of 13.7% fetches a price of Rs. 20/- per 25 lbs. The oil content is therefore no indication of the quality as judged by the trade. If clove plantations were to be successfully extended in India, the planters should have accurate knowledge of the standards according to which the quality of their produce will be judged. The marketing section of the Imperial Council of Agricultural Research should be in a position to render necessary help in the matter.

Mr Aiyer has rightly laid stress on setting up of co-operative planting experiments to be located in Madras, Travancore and Mysore which may be carried out by the Directors of Agriculture of these places with the Imperial Council of Agriculture Research as the co-ordinating agency.

Clove has been known in India from ancient times as a spice and a medicinal article and its cultivation in many parts of southern India is even now not extinct. In competition with cofee and tea however, these plantations have been sadly neglected. Clove is in indespensable article of consumption in India and the home consumption is rapidly increasing. Every effort should therefore be made to extend its cultivation and to make India self-supporting so far as this article is concerned. The quantity of clove consumed in India amounted on an average, to 73,500 cwts. per year during the last ten years.

The number of bearing trees required to produce this amount can be reckoned at about 9½ lakhs. This number is not so large as it may look, because if we suppose that they are raised as pure plantations, only the thousand acres of suitable land will be necessary. How small, from the point of extent this is, can be realised when one looks into the acreages of the various plantation crops such as tea, coffee, and rubber. The question whether the clove can be grown in India on a profitable basis has been answered in this report in an emphatic affirmative; and it now remains for the public and the Departments of Agriculture in Southern India to bring the schemes of clove cultivation to fruition.

Riddle of Plant Growth Substances

Dr William C. Cooper of the United States Department of Agriculture reports a series of experiments which throw new light on the process of increased growth of plants treated with plant hormones. He indicates that the real root forming substances are already in the plant and not in the treatment.

Several chemicals are known to promote rooting. Cooper used indole-3-acetic acid, one of the first chemicals identified as a growth substance. He treated lemon cuttings—soaking the base of each cutting in a solution of the chemical—planted part of them, and got the anticipated response more and stronger roots than from untreated cuttings. Part of his cuttings he did not plant. Instead he cut off the treated base sections and again treated the shortened cuttings. The second treatment did not stimulate nearly so much root formation as the first treatment.

Doctor Cooper says that the probable explanation of these conflicting results is that the chemical treatment causes the downward transport of naturally occurring root-forming substances which are already in the plant and which are necessary for root formation. For convenience in the discussion of these substances, they have been named rhizocaline.

Cooper's experiments with various other plants indicate that plants which do not root readily when treated—delicious apple cuttings, for example—are lacking in rhizocaline. The chemical nature of rhizocaline has not been discovered.

—*Science Digest.*

Notes and News

On the Script of Mohenjo-daro

In an article on the "Numeral Signs" of the Mohenjo-daro script published as a memoir of the Archaeological Survey of India, Prof. S. C. Ross, of the Leeds University, has made a study of the monograph of all the so-called numeral signs, which consist of a group of short and long strokes numbering from one to twelve. An analysis has been made by him also of the sign combinations. According to a newly accepted method for the analysis of sign combinations in undeciphered scripts, the so called numerals, it is shown, may not have stood for actual numbers, but most probably indicated a syllable of the spoken numeral of the base language used at Mohenjo daro. The suggestion is accordingly made that in the language of Mohenjo-daro, numbers were perhaps expressed somewhat in the same way as in English in that the decimal system was used and a simple compounded word for each of the numbers from "one" to "ten" as also a specific word for twelve (like dozen) existed. The general character and particularly the numerals of the alternative families of languages, such as the Dravidian, Munda or Burushaki, etc., have also been examined, and the conclusion is reached that the actual character of the signs in Mohenjo-daro agrees with the hypotheses that the language was an old form of the Indonesian family, which now includes Malay and Javanese, etc. The idea that script might have been Indoaryan is considered as entirely out of the question.

Recent Advances in South African Pre-history

Twenty years ago very little was known about African pre-history. The researches of the last two decades, however have revealed, to some extent, the story of man's past in this continent "though even to-day much of the continent is still unexplored. We have learnt enough to realize that this great land-mass has played an important part in the story of the human race, and indeed, has had its effects upon ancient Europe," writes Prof. A. J. H. Goodwin, of the University of Cape Town, who excavated the Oakhurst rock-shelter, near George, in Southernmost Africa, in an interesting article on "Recent Advances in South African Pre-history" in SCIENTIA 1-6-1938 Recently considerable advance has been made of in our knowledge of prehistoric Africa in all the three major periods, *i.e.*, the Earlier, the Middle and Later Stone Ages. First, both in importance and in time, is the recent survey of the Vaal River gravels undertaken by the Bureau of Archaeology. Second, is the discovery of a Neanderthaloid skull at Florisbad in the centre of the Orange Free State, by Prof. T. F. Dreyer. Finally, there are the author's own excavations at the Oakhurst rock-shelter. These three factors constitute the major advancements in our knowledge of South African pre-history during the past few years. In his article two important material facts contrasting with European conditions, have been brought out. These are the absence of glacial phenomena, and the lack of flint over the greater part of Africa.

Practice of Pharmacy in India

Pharmacy is essentially a system of public service. The state of pharmacy, however, in India can only be described as chaotic. "If the present needs of the country in the matter of an efficient public health service are to be adequately met and if the tremendous undeveloped drug resources of the country are to be utilized, it is essential that the training of the pharmacists should be improved. Secondly, it is important that a correct conception of the nature of the profession and its functions and importance should be appreciated by the public. For this purpose an active educational propaganda has to be carried out." Thus observed Bt-Col. R. N. Chopra, I.M.S., presiding

over the third annual session of the Bengal Pharmaceutical Association at Calcutta. He next referred to the appointment of the Drugs Enquiry Committee which suggested in its report the enactment of a legislation to control both the adulteration of drugs and to organize and superintend the training of persons who practise pharmacy. In these directions the Bengal Pharmaceutical Association has been doing useful work since its foundation about three years ago. But it is regrettable that since April 1931, when the report by the Drugs Enquiry Committee was submitted, no progress as outlined by the Committee has been found to be possible by the Government of India excepting that an imperfect piece of legislation under the name of "Import of Drugs Bill" was introduced in the Central Legislative Assembly which went to the Select Committee stage in October last, 1937. This Select Committee was later adjourned *sine die* after expressing that the proposed bill be substituted by a more comprehensive legislation on the recommendation of the Drugs Enquiry Committee. The only work that stands to the credit of the Central Government in this direction is the establishment of a nucleus of a Central Drugs Control Laboratory in the creation of the Biochemical Standardization Laboratory at the All-India Institute of Hygiene and Public Health which also began its work so late as in 1937. But unless suitable legislation is in force the work at this laboratory will be of no practical use.

British Admiralty Research Ship

Under the superintendence of Sir Stanley Goodall, Director of Naval Construction, the Royal Research Ship *Research* is under construction for the admiralty by Messrs Philip & Son Limited at Sand Quay, Dartmouth. The ship is meant for investigations into terrestrial magnetism and atmospheric electricity in different ocean areas. This work was carried out till 1929 by the American Research Yacht *Carnegie* upto the time of her loss by fire.

The *Research* would be 142 ft. 6 in., in length on the water line, breadth 34 ft., maximum draught 13 ft. 2. in., and loaded displacement 770 tons. It will mainly work under sail. On account of the nature of work for which she has been designed and the delicate instruments which she will carry on board, the use of magnetic material has been avoided as far as possible. The hull of the ship is of teak plank on brass frame, copper sheathing is fitted throughout and 80 tons of lead has been used as ballast, anchors, cables, wire-rigging are of aluminium bronze and drinking water tanks are of teak-wood. The Diesel Engine which is to be used as the propelling machinery is practically designed to be made out of bronze alloy and the crank shaft is of non-magnetic steel. There would be dynamos, refrigerators, air compressor, fitted up for different purposes and each one is of special design. Even the ship's typewriter and the nails in the packing cases are non-magnetic. The ship would have a complement of 6 officers and 22 crews and staff of 4 scientific observers. The vessel is expected to be launched in February 1939. She will proceed first to the Carnegie Institute, Washington and then to South America and will make a circuit of the Indian Ocean and return back to home waters in 1940.

The ship is to demonstrate the essential truth of the aphorism that "science knows no frontiers" even by the British admiralty with her complement of dreadnaughts and submarines.

What should be your Radio Set?

It is sometimes believed by the radio subscriber that the value of a radio set depends on the number of valves in it. It is total sensitivity and quality of reproduction that matters not the valves. Mr F. C. Ramsell, speaking at the Calcutta Rotary Club on September 6, 1938, advised the radio set buyer with a limited sum of money to spend, to purchase a plain set, *i.e.*, one which had no subsidiary circuits and one which used its four or five valves solely for the purpose of signal amplification.

As for the person who had a fair amount of money to spend on a radio set, he advised him to make sure whether he considered high fidelity reproduction or long-distance reception of paramount importance. If it was high fidelity, the set should have a large loud speaker, and it should be fitted with a push-pull arrangement of output valves. If it was long-distance reception which was required, then the set should possess two stages of I. F. amplification, even if high fidelity circuits had to be sacrificed.

Proceeding, Mr Ramsell said that if the owner of a radio set wanted good reception—as free as possible from interference caused by fans, refrigerators,

motor-cars, trams, etc., it was imperative that the aerial should be erected at least 30 feet above all possible sources of radiation of the unwanted noises. It should also be at right angles to the chief source of interference, and, having once got the aerial reasonably clear of man-made statics, it was equally imperative that no unwanted impulses be picked up on the down-lead (which conveys the signal from the aerial to the set). This, he said, could only be accomplished by using a shielded wire, or the hoisted flex of Dipole aerial. Regarding interferences caused by nature, such as electrical storms, there was little which could be done to eliminate them. Many systems had been invented but none had been able to entirely eliminate these noises.

The New Vice-Chancellor of the Calcutta University

The Hon'ble Mr Azizul Haque, at present President of the Bengal Legislative Assembly, and formerly Education Minister, has been appointed Vice Chancellor of the Calcutta University in place of Mr Syama Prosad Mookerjee, whose term expired on the 22nd August last. He possesses wide experience in educational matters of this Province, and, as such, is eminently fitted for his new responsibilities. We hope and trust that under his able guidance the University of Calcutta will continue to progress in every sphere of its activities as during the regime of his predecessor. It is quite in the fitness of things that the University has conferred on Mr Mookerjee the degree of Doctor of Literature *honoris causa* as a mark of the appreciation of the good work done by him during the four years of his administration.

The Death of Prof. J. R. Banerjee

The death occurred at Calcutta of Prof. J. R. Banerjee on September 6, 1938. He was a prominent figure in the educational circle of Calcutta and an educationist of note. He was the Principal of the Vidyasagar College, Calcutta, for 1924-34. Prof. Banerjee was intimately connected with the Calcutta University for over a quarter of a century, having been a member of its Senate and Syndicate from 1911 to February 1938. He was Dean of the Faculty of Arts for two years and connected with various boards of studies of the University.

The Study of Nutrition in India

The need for proper dietary surveys in the different parts of India has been stressed several times in these columns. Some surveys are under way, and details of diet surveys carried out by the Nutrition Advisory Committee in Mysore, Travancore and Kashmir States, Assam and several other parts of India where the work is still in progress are now available. We all know how important these investigations are for defining the problem of nutrition in this country, for they clearly demonstrate the deficiencies of typical Indian diets. The relation between signs of deficiency disease and certain indices based on body measurements has been extensively studied; such work is expected to lead to fundamental knowledge about changes in body structure resulting from malnutrition, and it is hoped to evolve a simple method of detecting malnutrition based on these body measurements, which can be used to study the incidence of malnutrition in groups of school children. The effect of skimmed milk in accelerating growth and improving the general condition having been demonstrated by experiments in boarding schools, similar investigations were extended to groups of poor day-school children.

Education and Administration

Mr John Sargent, Educational Commissioner designate to the Government of India, presided over the Educational Science section of the British Association meeting at Cambridge. He has been Director of Education at Essex and, has served for a long time with local administrative bodies. His presidential address bears testimony to his intimate knowledge of the complex relation between local self-governing bodies and educational organization in England. Mr Sargent apparently is in love with the British system. Though he will be confronted with a wider area with a far more complex relation between Central, Provincial and local administrative bodies on the one hand and different cadres of educational institutions on the other, we hope Mr Sargent will bring to bear on the educational problems of the country the catholicity and vision which inspires his address, extracts from which are given elsewhere in this issue.

Indian Science Congress Association, Silver Jubilee Session

The report by the local Secretaries and the audited accounts of the last Silver Jubilee Session of the Indian

Science Congress Association present a very bright picture of the co-operation in various ways, particularly in the form of donations and of the hospitality offered to the delegates, received from the citizens of Calcutta and public bodies including a large number of commercial and industrial organizations. Their assistance contributed to the splendid success of this important session. The total grant of the Calcutta University in connection with the celebrations is Rs 15,000/- including Rs 2,500/- to the local reception committee. Besides this, the various educational institutions of the city largely helped in one way or other in attending to the various details of the programme. The total expenditure was Rs. 25,376 and odd. It is interesting to note that the number of members registered in the Association was 2,458 of which more than 2,200 attended; whereas only 739 were present at the 22nd Session at Calcutta in 1935.

Royal Institute of Science, Bombay

The Royal Institute of Science of Bombay has issued its third report for the period 1934-1937. It may be recalled that the Institute commenced teaching work in 1920 for undergraduate and post-graduate classes. But from June, 1937 the undergraduate classes have been removed to Elphinstone College where languages are also taught. The cost of education per head was on the average per year Rs. 680 of which Rs. 260 were met by the Government of Bombay. The annual expenditure per year was near about Rs. 1,95,000. The staff of the Institute has 159 notes and papers to its credit for the period under review, chemistry leading with 102 papers. The abstract of these are appended in the report. A very interesting chart is included which shows that 36·4% of the alumni are college teachers and 21·8% are in science posts in industries. Those employed in Research Institute and the research scholars make a total of 5·4%. It is significant that pure research work is being done by 0·6% and those studying abroad (the majority of whom aspire for covetable easy jobs) amount to 6·7%. These figures are made from a total of 165 students who were in the post-graduate departments during 1925-37. The report rightly points out that quality of research work is suffering because the batch of research workers mentioned above are either preparing or waiting for lobs to not-very-suitable grade of which they surrender and if necessary may also refund the money. We may add such a situation prevails all over this country.

Are the Jews Unproductive?

Man is defined as 'a rational animal', his distinctive characteristic being rationality. It is this quality that has made him the most powerful living being. He has conquered the forces of nature and harnessed them for his multifarious use. He has mastered science, which has given great power.

But man has also evolved a system of ethics. He has perhaps built it up for his own convenience and comfort, for he wants to keep up the Society in which he has constantly to move. He needs a well-ordered Society for the satisfaction of his primary instincts of sex, hunger, and group-associations.

But ethics itself has got to be rational and its study must at all costs tally with the dictates of reason. The ethical principles must be rational and stand the searching test of ordered reasoning. The result is that man has gradually cultivated a scientific outlook.

It is therefore sometimes highly puzzling to find men preaching and holding opinions apparently against reason. There are men obsessed so much with hatred that they are guided more by the dictates of the heart than by those of the head. Psychologists will perhaps explain this obsession as a 'complex'.

We do not know how the Jew-complex of Herr Hitler can be explained. Psychoanalysis will no doubt reveal it. But is not psychoanalysis the production of the brain of Freud who is a Jew, and is therefore, as declared by the Fuhrer at Nürenberg, unproductive? The opinion of the Nazi Leader cannot be loose talk, pronounced in the heat of a moment, but is the result of careful thinking and deliberation. But the literature describing the new Hitlerian theory have not given any cogent reasons to support so original a thesis. This gives rise to serious doubts about the validity of the proposition. For, let us consider Freud, Ehrlich, Einstein, Haber, Meyerhoff, Warburg, Wasserman, Hertz and a host of other famous names in their respective fields of knowledge. Are they, then, to be henceforth called unproductive, since Herr Hitler has declared them to be so? The declaration is preposterous and appears to be the outcome of a brain suffering from the Jewish complex.

SCIENCE IN INDUSTRY

India's Industrial Future

Though it is admitted on all hands that progressive industrialization will mean for this country a rising standard of living and afford enlarged opportunities to the people, doubts are often expressed as to the possibility of industrialization solving the unemployment problem. We agree fully with Mr N. R. Sarker, Finance Minister, Bengal (in his address on the prospects of industrialization in India, delivered at Gwalior) that the maximum amount of industrialization will not of itself solve the problem. It would no doubt relieve economic distress of the rural population as much by enlarging opportunities for employment as by stimulating demands for raw materials for the industries. Much also depends on the growth of population on the one hand and the development of national resources on the other. According to Mr Sarkar, therefore, " India's policy of industrialization should thus be determined on the basis of the requirements of her own economic order. In certain details, India may initiate and adopt with profit the industrial methods and technique of other countries. But the main objective of our policy should be a broad-based and remunerative agriculture succured by flourishing cottage industries and further sustained by the development of larger industries."

During the last twenty-five years, however, the world has witnessed with disbelief and suspicion the great economic drama enacted on the soil of Russia. In the days of the Czar, the conditions, material and social, were very much the same as we find in India to-day. Nobody could then believe that the problem of Russia's poverty and unemployment could be solved by industrialization alone. But to-day we find that the whole outlook has changed. A new era has been ushered into the land. Industrialization alone has completely eradicated unemployment. That is not because the rate of population has gone down since the days of the Czar—but because Soviet Russia has known how to adjust itself to the sudden increase in population. France, Germany, Italy, Japan, Great Britain, Holland —all these countries have each a greater a density of population than India. She is also far richer than any of these in the matter of her natural resources. She possesses, perhaps in excess, latent national wealth which if properly tapped and developed should meet the demands of her whole population and more besides. Efforts must therefore be made to utilize fully the resources of the land, to strengthen man power, and raise social, health and economic standards through the advancement and application of science. This is unlikely to achieve so long as capitalism continues in its present form at least.

Gold-Plated Glass

To the credit of Prof. Charles S. Gibson goes the discovery of what is described as a new and easy method of depositing film of pure gold on glass or other surfaces. The examples of his work were recently included among the exhibits in the South African Court of the Imperial Institute, South Kensington, England. According to Prof. Gibson, brilliant films, the heaviest of which is only 0·0004 mm. thick have been deposited chemically on suitably prepared surfaces. By reflected light they appear as massive gold, and by transmitted light show the beautiful greenish-blue colour characteristic of thin gold films. They are capable of being polished, but can be produced in such a manner as to render this unnecessary. The thickness can be varied by altering the condition of the reaction and the conditions of the reactants. Pure gold films are actually more easily produced than those silver, and chemically they are much more inert." The process discovered by Prof. Gibson is said to have considerable scientific value, besides the point of view of luxury.

SCIENCE IN INDUSTRY

Storing Eggs

The new vacuum-carbon dioxide oil treatment to keep eggs fresh in storage has been applied on a commercial scale and found to be much superior to other commercial methods of shell treatment. A carload of eggs was stored six months in New York City. Sixty-five per cent of the eggs oiled by the new vacuum-carbon dioxide method went into storage as U. S. Extras, and 63 per cent. came out still in the same grade. But of the eggs oiled by the ordinary dip method, 73 per cent went into storage as U. S. Extras and only 39 per cent came out in that grade of the untreated controls, 77 per cent went in and 10 per cent came out as U. S. Extras.

The eggs are placed in a Vacuum Chamber which draws the air out of them. Then they are dipped in a tasteless, odourless mineral oil in the chamber and placed in carbon dioxide. The eggs automatically pull some of the carbon dioxide saturated oil into the pores of their shells—*Science Digest.*

Industrial Article for October

'Power Alcohol' by Dr N. G. Chatterjee, D.Sc. of the Harcourt Butler Institute, forms the industrial article of this issue of our journal.

Power Alcohol

N. G. Chatterjee
Harcourt Butler Technological Institute, Cawnpore.

In this paper, I propose to confine myself to the possibilities in the United Provinces of generating power by the use of alcohol fuel.

In the absence of indigenous supplies of coal or petroleum within these provinces, it is but natural that greatest attention should be paid to ethyl alcohol, as it is the only alternative fuel, the supplies of which can be drawn from recurrent vegetable sources instead of the nature's fixed capital of mineral wealth. The rapid development of the internal combustion engine as generators of power in motor cars, tractors, and stationary engines of small and medium power, is leading to an ever-increasing demand for a volatile liquid fuel, which is at present being almost wholly met by imported petroleum, entailing huge drainage of national wealth. We have therefore to enquire, on the one hand, into the possibilities of finding prolific and cheap indigenous sources of alcohol, and on the other hand, into the suitability of alcohol as a motor fuel.

Sources of Alcohol—On account of the rapid growth of the sugar industry in these provinces, there is now a large surplus of molasses, the disposal of which is an acute problem. Molasses is an ideal raw material for the manufacture of alcohol, so that in it we have an abundant supply of cheap raw material, distributed all over the province. It is estimated that in the United Provinces, about 200,000 tons of surplus molasses would be available per annum, at a price not exceeding annas -/4/- per maund. Indeed our information is that the average price received by the sugar factories for molasses during last year was only about Rs. 0-1-2 per maund. Assuming that one ton of molasses would produce 60 gallons of alcohol, it would be seen that in surplus molasses we have a potential indigenous source of supply of about 12,000,000 gallons of alcohol.

Comparison of Alcohol and Petrol—The main points in which alcohol differs from petrol as a fuel may be summarised as follows:—

(1) The vapour pressure of alcohol at low temperatures is lower than that of petrol. In consequence of this the alcohol motor is more difficult to start. This can easily be remedied in different ways.

(2) Alcohol takes longer to burn to explosion than petrol; hence the alcohol motor should have a higher compression and a longer stroke than the petrol engine.

(3) The mixture of alcohol vapour and air can safely be subjected to a pressure of 200 atmospheres, whereas the safety limit for petrol is 80 atmospheres.

(4) Mixtures of alcohol vapour and air have a wider explosive range than is the case with petrol. This permits of greater latitude in the air supply.

(5) Alcohol vapour requires less air for its combustion than petrol vapour; hence there results more thorough mixing in the case of alcohol and consequently the combustion is more complete.

(6) The heat of combustion of alcohol is much lower than that of petrol. But this disadvantage may to some extent be compensated by the higher latent of alcohol, and the larger increase in specific volume of the products of combustion, so that a mixed petrol alcohol fuel in certain proportions may actually show a slightly better efficiency than straight petrol.

Alcohol Fuels These may be divided into two classes:-

(1) Hydro carbon fuels containing alcohol.

(2) Straight alcohol.

Of these, the first type has received most attention and large quantities of such mixed fuels are being used in almost every country in the world for driving motor cars in place of pure petrol. It is now established beyond dispute that a mixed fuel consisting of petrol containing absolute alcohol to the maximum extent of 25% is just as good a motor fuel as straight petrol. Indeed certain distinct advantages are also claimed for such types of petrol-alcohol mixed fuels.

This subject has of late been widely discussed in this country, so that it would suffice to say that such petrol-alcohol mixed fuels can be indiscriminately used with entire satisfaction in place of petrol in all kinds of motor cars, without feeling the necessity of making any alteration in the engine or even the carburettor.

The behaviour of petrol-alcohol mixed fuels in engines designed for petrol when the proportion of alcohol is increased is summarised below:

(*i*) Mixtures containing 0 to 15% of alcohol behave practically the same as pure petrol and in use do not require any change in the carburettor. The consumption of the fuel is of the same order. A more smooth running of the motor is noticed.

(*ii*) When the quantity of alcohol in the mixture is increased it is found that at about 20-25 per cent alcohol the working of the motor is always very smooth and in actual practice, a slight diminution in fuel consumption may be observed.

(*iii*) When the proportion of alcohol is raised to about 30-35% the mixture falls down again so far as fuel consumption is concerned, to the standard of petrol, or perhaps a slight increase in consumption may be noticed. The flexibility of the motor continues to be perfect, but a regulation of the carburettor and spark control becomes almost a necessity.

(*iv*) When the alcohol proportion is still further increased, it becomes absolutely necessary to modify the carburettor and the control, while the fuel consumption increase rapidly.

Strength of Alcohol and Fuel characteristics-

"Spirit of all strengths down to about 50% can be used for working internal combustion engines, assuming of course, that the latter have been properly adjusted. The fuel consumption increases, for a given compression ratio and load, with the water content of the spirit. The change however, is very small an increase in strength from 80 to 90 per cent spirit brings about only an insignificant increase in the power of the engine. With spirit of strength between 100 and 80 per cent, the consumption of fuel is directly proportional to the water content of the spirit. With 70% spirit it is difficult to keep the engine going. Spirit of 50% strength brings about the maximum decrease in power and the efficiency of the engine is very low. The maximum power is 72% more when using spirit of 94% strength. The presence

of water in spirit admits of an increase in the compression ratio without premature ignition."

Theoretical Aspects of Engine Performance with Petrol and Alcohol (Lichty and Ziurys *Ind. & Eng. Chemistry*, September 1926).

The results are summarised in the following table, for the four different sets of conditions:-

Condition I Both fuels completely evaporated and at the same temperature, which requires much more heat input for the alcohol air mixture.

Condition II The gasoline completely evaporated and the alcohol 54 per cent evaporated, which requires the same heat inputs.

Condition III Both fuels completely evaporated, but at the minimum mixture temperature in each case.

Condition IV - No evaporation or heating of either fuel-air mixture.

	Condition I.		Condition II.		Condition III.		Condition. IV.	
	Gasoline at 101°F	Alcohol at 101°F	Gasoline at 101°F	Alcohol at 55°F	Gasoline at 101°F	Alcohol at 71°F	Gasoline.	Alcohol.
(a) Heating value .	100.6	100.0	102.0	100.0	100.6	100.0	100.0	102.2
Relative charge density . .	..	..	..	12.3	..	5.6	..	..
Expansion of product .	..	0.8	..	0.8	..	0.8	..	0.8
Sp. Ht. of product .	2.2	..	2.2	..	2.2	..	2.2	..
(b) Result per cent.	102.8	100.8	104.2	113.2	102.8	106.4	102 2	103.0
Net increase per cent.	2.0	..	..	8.6	..	3.5	..	0.8
Heat supplied per cent.	100	284	100	100	100	234	None	None

(a) Per unit volume of correct mixture at any standard conditions, corrected for condition of fuel.

(b) Results are computed as follows:-

Column 1: (1.006×1.022) 100=102.8.

Column 4: (1.000×1.123×1.008) 100=113.2.

Practical Tests of Engines run on Alcohol.—The theoretical deductions mentioned above have been to a large extent fully confirmed by the results of the practical tests conducted from time to time by different investigators. The following may now be accepted as fully established:—

(1) Alcohol of strength 94-96%, may be used as fuel in ordinary engines designed for working on petrol, with minor changes in the carburettor and float. The consumption of fuel would be approximately 50% more than that with petrol.

(2) In engines specially designed for working with alcohol (increased compression). Higher power may be obtained, while the fuel consumption would be about 33% more than with petrol for the same power.

In general, therefore, it is seen that the petrol engine requires some modifications to suit it for alcohol fuel. It is important to observe that whereas the best condition of working with petrol as fuel are known very fully, the work on straight alcohol fuel is of a pioneer nature, and it is doubtful whether full justice has yet been done to alcohol.

Method of manufacture of alcohol.

Alcohol is manufactured by the rectification of the dilute solution obtained after the fermentation of sugar or starch bearing materials is complete. The usual strength of this fermented wash as it is generally called is about 6-8%. Due to certain peculiar properties of a solution of about 96 parts by volume of alcohol and

4 parts of water, this is the maximum strength of alcohol that can be obtained by straight rectification of the 'fermented wash.'

The manufacture of industrial alcohol is at present being carried out in all distilleries in India equipped with patent continuous stills. In fact, the alcohol as it comes out of these stills is what is known as 'rectified spirit' and the strength varies generally from 90% to 96% by volume. The subsequent manipulation of this spirit in warehouses by the addition of water, chemicals, or other substances, converts it into various froms of drinking spirit, 'methylated spirit,' or 'specially denatured spirit.'

Further dehydration of rectified spirit was till recently a matter of considerable difficulty, and the usual process of getting 'absolute alcohol' was by distillation with lime. This was a costly process and entailed considerable losses in working. But within the last fifteen years or so, at least two different processes have been developed and have met with considerable commercial success. These are commonly known as the azeotropic process and the salt dehydration process. The following table (*International Sugar Journal*, March 1938) gives the present annual production of absolute alcohol by these processes:

World production of Absolute Alcohol (1937)

I. *Azeotropic process.*

1 Hectrolitre = 22 gallons

	Hectrolitres
(a) Melle system	5,250,000
(b) 'Drawinol' system	3,000,000
Total	8,250,000

II. *Salt-dehydration & other processes*

(a) Hiag system (alkali acetates)	3,975,000
(b) I. G. F. system (gypsum) ..	265,000
(c) Merck Pressure system (lime)	120,000
Total	4,360,000

Importance of Commercial dehydrated alcohol. It may well be asked what was the necessity for the commercial manufacture of cheap dehydrated alcohol. The reason is that dehydrated alcohol has a much wider range of miscibility with petrol than rectified spirit, which was found to be unsuited for the preparation of alcohol petrol mixtures, in the proportions in which the latter were found to be best as a motor car fuel. Mixtures of rectified spirit with petrol tend to separate easily, and thus give rise to trouble. On the contrary, mixtures made with dehydrated alcohol and petrol have been found to be stable and perfectly satisfactory for all practical purposes.

It may be interesting to note that with the success achieved in the commercial manufacture of dehydrated alcohol, the world consumption of the latter for purposes of preparing mixed motor car fuels has been rising rapidly as is shown by the following table for the two countries, France and Germany.

FRANCE.		GERMANY.	
1931-32 ..	18,827,000 gals.	1931-32 ..	25,657,000 gals.
1932-33 ..	12,658,000 ,,	1932-33 ..	34,593,000 ,,
1933-34 ..	54,388,000 ,,	1933-34 ..	15,823,000 ,,
1934-35 ..	81,521,000 ,,	1934-35 ..	18,509,000 ,,
1935-36 ..	88,000,000 ,, (probable figure)		

As dehydrated alcohol is now almost exclusively used for the generation of power and as recent researches have evolved processes so that now there is little difference between the cost of manufacture of dehydrated alcohol and rectified spirit, 'power alcohol' has now become almost synonymous with dehydrated alcohol. It seems, therefore, that for power purposes the use of denatured rectified spirit of about 96% strength is an anachronism and should be given up.

Cost of manufacture of power alcohol. A good deal of false cry seems to have been raised a few years ago on the question of cost of manufacture of power alcohol, but fortunately this has now practically died out.

This estimate was presumably based on the working of a distillery with a plant capacity of about 1,500 gallons per day. The writer however is convinced that in a distillery of sufficiently large capacity, the cost of production of power alcohol without the addition of any denaturant, would not exceed Rs. 0-4-6 per gallon, with molasses at -4- per maund delivered at the distillery. One of the most important factors to

bring about this reduction is the fact that within the last month an agreement has been reached by which the patentees of one of the most important processes for manufacturing power alcohol are to charge only a nominal sum for the use of their patent in place of about 5 pies per gallon which they at first wanted to charge.

Cost of generating power with alcohol fuel In an ordinary engine designed for running on petrol, it has been found that the consumption of fuel when using alcohol of 96% strength, may be about 0.66 litre per B. H. P. hr.

The following results were obtained by Prof. Wawrziniek, in experimenting with 96% spirit and petrol in different makes of motor car engines. The engines were of the following make:

	Power.	Compression Ratio.	Volume of the engine cylinder.
I. Daimler, Lorry motor	35 H.P.	4.0	5.5 litres.
II. Adler, Private car motor	10 30 H.P.	4.2	2.62 „
III. Elite, Private car motor	10 40 H.P.	5.5	3.14 „

The results are tabulated below:—

Engine.	Fuel.	Effective power developed.		Average consumption of fuel.	
		500 r.p.m.	1000 r.p.m.	Kg/H.P. hr.	Litre H.P. hr.
I	(i) 96% spirit	17.4	27.1	0.517	0.630
	(ii) Petrol	18.5	31.25	0.331	0.440
		800 r.p.m.	2000 r.p.m.		
II	(i) 96% spirit	10.80	24.40	0.645	0.789
	(ii) Petrol	11.75	28.00	0.443	0.590
		900 r.p.m.	2000 r.p.m.		
III	(i) 96% spirit	14.2	37.60	0.512	0.626
	(ii) Petrol	25.0 (1150 r.p.m.)	38.5	0.347	0.461

It would be seen that the engines experimented upon had comparatively low compression ratio. One would therefore reasonably expect that in a properly designed engine of high compression and using dehydrated alcohol denatured with say 6-8% of kerosene, the consumption of fuel per B.H.P./hr, be very nearly the same as with petrol in an ordinary petrol engine. In other words, we may safely assume that in the alcohol engine, the consumption of fuel may be reckoned at about 0.55 litre per B.H.P./hr. If the fuel is available at -/6/- per gallon, the cost of the fuel would be about 11.2 pies per kWH.; in other words, the overall cost of generating power in an alcohol engine may be within one anna per unit.

This compares quite favourably with the charges for hydro-electric energy in the U.P. In answer to a question in the Legislative Council, the spokesman for the Government is reported to have given the information that the total cost of providing each unit sold in the hydro-electric scheme during 1936-37, was 11.64 pies and the average sale price per unit sold was 12.24 pies, and further that the charges were already so low that there was no room for further reduction for some time to come.

Excise Restrictions One factor which may impede the development of power-alcohol in this country is the existence of excise restrictions framed many years ago before power alcohol entered into consideration. It is essential that restrictions against the use of power alcohol should be relaxed considerably, and this is possible only when a suitable denaturant has been found.

Power-Alcohol and Provincial Government revenues There is one point of paramount importance in connection with the use of power-alcohol. Under the Government of India Act of 1935, any excise duty levied on alcohol used for generating power or for the matter of that for most industrial purposes is liable to go to the central revenues. At the same time, it is yet doubtful if any kind of vend fee can be levied by the Provincial Government on power alcohol. The only way therefore in which the Provincial Government can derive any revenue from the power alcohol industry is to take up the monopoly of the industry as has been done in most other countries. There should not be any serious objection to this, as a scheme can easily be devised by which without affecting the interests of the existing distilleries, the industry may be made to yield some revenue to the province as a small recompense for the loss on account of the introduction of prohibition. By a clever adjustment of the sale price of denatured alcohol for general power purposes in comparison to that of kerosene, it may not

be difficult to make an average net profit of about annas two per gallon without entailing any hardship on the consumer.

Concluding remarks—I have endeavoured to show that the only fuel, apart from wood, available in the United Provinces is alcohol, for which there is at present an abundant supply of raw material in the form of molasses. While most of the countries of the world are willingly suffering financial losses in trying to replace imported petrol by indigenous alcohol, in these provinces it would be possible to use power alcohol with considerable financial gain to the country.

It is therefore submitted that the technical and economic aspects of developing power for agricultural purposes—wherein the problem of distributing cheap power over a wide spread area with small intermittent consuming units is acute by means of alcohol engines should receive serious consideration when developing any consolidated scheme for the efficient conservation, utilization and distribution of power in these provinces.

Perfected Fluorescent Lumiline Lamps

Invisible sunrays, imprisoned within tubular glass bulbs, and bombarding chemical powders which serve as energy transformers, are now being used to produce cool light sources that duplicate all the pastel tints of the rainbow.

The new light sources, designated as fluorescent lumiline lamps, provide hitherto unobtainable tints of colored light with, in some cases, as much as 120 times the illumination, for the current consumed, as filament lamps of the same color, and with only a fraction of the heat. One of them produces the nearest approach to natural daylight ever achieved by any artificial illuminant.

Fluorescent powders, compounded in the Nela Park laboratories of the General Electric Company and specially heat treated, hold the secrets of efficiency and color-producing qualities of the new lamps, it has been revealed. Activated by ultra violet, and functioning as transformers, the powders absorb the short, invisible ultra-violet rays and re-radiate this energy in those higher wave-bands that comprise the color range of the spectrum. Each powder has its own characteristic wave-band with which it responds to the ultra-violet, thus forming its own particular color of emitted light.

Within the bulb of the new fluorescent lamp is a trace of mercury, a small amount of argon gas at low pressure, and a coating of the fluorescent powder. When the current is turned on, the argon serves as a "starter," and in a fraction of a second a feeble blue light with a large component of invisible ultra-violet radiation is generated inside the tube. The ultra-violet radiation strikes the fluorescent coating and is re-radiated in the visible range of the spectrum. Like all electric-discharge light sources, the fluorescent lamps require special transformers, or chokes, which serve as valves in controlling the flow of electric current. Unlike some other types of mercury-vapor lamps, however, they attain full brilliancy in a few seconds.

Among the many fields of application for the new fluorescent lamps might be listed the following: theatres, hotels, specialty shops, stores, beauty parlors, art galleries, architectural built-in lighting in many forms, railway cars, and so on.

—*Scientific American*

MEDICINE AND PUBLIC HEALTH

Causal Factors in Epidemic Dropsy

The September issue of the *Calcutta Medical Journal* contains an article by Dr R. B. Lal on the possibility of certain toxic constituents of mustard oil acting as a causal factor of Epidemic Dropsy. These toxic constituents might arise from adulterants or diseased seeds. Experimental and epidemiological evidence points to its being a chemical poison rather than a living virus. Allylisothiocyanate and bromacetic ester are the common adulterants used to impart pungency to the oil. Hydrogen cyanide has also been shown to be present in comparatively large amounts in certain consignments of mustard oil. In view of Dr Lal's experiments, it is difficult to support the contention of Dutt (Dutt, S. SCIENCE AND CULTURE; 3, 255, 1937; also Mukherji, B, SCIENCE AND CULTURE; 3, 441, 1938) regarding the role of hydrogen cyanide.

The vitamin and rice theories now seem to be abandoned. Sufficient attention has, however, not been paid to fungal disease in mustard seeds, the most frequent of which is *Alternaria Brassica*. A thorough study of the fungal diseases of mustard seeds is, therefore, urgently called for.

Swiney Prize for a Work on Medical Jurisprudence

The prize, which consists of a cup valued at £100/- *plus* money to the same amount, is offered by the Royal Society of Arts, John Street, Adelphi, London, W. C. 2, alternately for medical and general jurisprudence, but if at any time the Committee is unable to find a work of sufficient merit in the class whose turn it is to receive the award, it is at liberty to recommend a book belonging to the other class. The next award of the Prize will be made in January, 1939. The work is to be submitted to the Secretary of the Society, not later than November 30th, 1938.

The Extent and Intensity of Extreme Ultra-Violet Solar Radiation at Calcutta, with Special Reference to its Therapeutic Value *by Prof. P. N. Ghosh, Dr J. C. Ukil and Mr M. K. Sen,- Jour. Ind. Med. Assn.*, Nov. 1936.

This investigation recorded, for the first time, the extent and intensity of biologically active (3300A° to 2900A°) zone of the ultra violet radiation of Sun's rays at Calcutta.

The authors described in detail the characters of solar radiation and discussed the experimental methods for measuring the intensity of ultra violet radiation. For their own investigation they have adopted a photographic photometric method which is, they think, better than photo chemical method as "it is capable of evaluating accurately the energy of the aforesaid biologically active region of the spectrum uniquely."

The investigation determined the intensity of the radiation and its variation during the course of a day and also for the different months of a year. Their findings showed that the maximum intensity of the radiation was present for about three hours of the noon time. It declines in the mornings as well as in the evenings. The month of June recorded the highest intensity and July the maximum extension. The fall is rather quick both in May and in July.

In the months of March, April, May, June and July the rate of increase of the longer wavelengths is much more quick than in the other months. This seems to indicate that along with the increase of ultra-violet rays there is also an increase of both luminous and heat rays in those months.

The months of March, April and May recorded much weaker ultra-violet radiation. The reason probably was the scattering of the rays by finer dust particles carried high in the atmosphere by the nor wester winds.

The intensity of the morning rays was very much less than that of the midday in the months of May to September and also in the winter months. The authors thought this to be due to the scattering effect produced by suspended particles in the atmosphere and by the smoke of house fires in the winter months.

P. K. S.

International Post-Graduate Medical Courses in Berlin

The Berliner Akademie für arztliche Fortbildung, is holding the following medical post graduate courses in autumn of 1938.

1. Course in the field of internal diseases in which lives are suddenly endangered (from 3rd to 8th of October) -Fee: RM. 50.
2. Post graduate course on the subject of ailments of muscles and joints (from 10th to 16th of October) Fee: RM. 50.
3. Progress in the field of hormones and vitamins (from 17th to 22nd October) Fee: RM. 50.
4. Course on tuberculosis in the Berlin Municipal Hospital for Tuberculosis (from 24th to 29th of October)- Fee: RM. 50.
5. Course in diseases of the ear, nose and throat (from 26th of September to 8th of October). Fee for the whole course: RM. 150; for the theoretical part of the course:—Fee RM. 100.
6. Course in accident-surgery (from 17th to 22nd of October)- -Fee: RM. 70.
7. Post graduate course on the subject of neurotic diseases (from 24th to 29th of October)- -Fee: RM. 50.
8. Propaedeutic respectively additional training course in homeopathy (from 10th of October to 5th of November). The course is divided into two parts. The fee for part one is RM. 25. Part two can be taken independently from part one at a fee of RM. 50. Both parts together RM. 75.- For assistant doctors RM. 15, RM. 30 and RM. 40 respectively.
9. Special courses in all branches of medicine with practical work at the bedside and in the laboratory, to be held every month For these courses participants are requested to communicate their wishes in order to find a complete programme on their arrival.

Courses 1 to 8 will be held in German, and the special courses also in foreign languages. For programmes and further information apply to the Geschaftsstelle der Berliner Akademie für arztliche Fortbildung, Berlin NW 7, Robert Koch Platz 7 (Kaiserin Friedrich Haus). Foreign doctors and German doctors resident abroad are granted a reduction of fare of 60 on the German Railways Company's lines; a foreign doctor can reduce the cost of his stay considerably by utilizing the so-called "registered marks"; it is advisable to arrange matters with the local bank before starting.

Medical Article for October

The following article 'The Gland that makes a woman what she is' has been contributed by Dr S. K. Mukherji for our 'Medicine and Public Health' Section of the present issue of the journal.

The Gland that Makes a Woman What She Is

Santosh Kumar Mukherji
Editor, *Indian Medical Record.*

Woman is woman mainly by reason of her ovaries. Her beautiful figure and soft voice of which the poets have sung for ages depend to a great extent on these small glands. They are to the woman what the testes are to the man.

The ovaries are two little glands, one on either side of the uterus or womb. They are flattened ovoid bodies. The surface of the ovary before puberty is smooth, but after puberty it becomes puckered in appearance. In old age ovaries become atrophied. The ovary is made of a stroma, with numerous follicles scattared in it. The follicle contains an ovum and a transparent fluid.

Function of the Ovaries

(1) At the onset of puberty--

The ovaries contain follicles. At the onset of puberty or the beginning of the period of sexual activity the hormone or internal secretion of the front portion of the pituitary, a small gland inside the skull, stimulates these follicles in the ovaries. As a result of this action the follicles mature and secrete a hormone, the *estrin*, producing striking changes as a result of their activity.

This follicular hormone of the ovary plays an important part in the development of the secondary sex organs in woman, that is, the uterus (organ for holding the child during pregnancy) and breasts. The breasts enlarge, the uterus increases in size, menstruation and discharge of ova begin and the girl is transformed into the woman. Removal of ovaries *before* puberty results in failure of development of the uterus and the feminine characteristics.

(2) From the time of puberty up to the age of 45 or 50-

Puberty is a period of great change in girls and three important events are started at this time, namely

(*i*) Expulsion of eggs from the ovary, which is necessary for conception.

(*ii*) Menstruation.

(*iii*) The formation of a new structure, the *corpus luteum*, secreting an internal secretion or fluid.

These three events are related to each other. We shall now describe them in brief.

(*a*) *Expulsion of eggs from the ovary*--The follicles in the ovary contain the ova or the eggs. It is the combination of these female ova or eggs with the sperms (Spermatozoa) in the semen of men that brings about reproduction. About the time of a menstrual epoch the follicles mature and burst, discharging the ovum.

(*b*) *The formation of the corpus luteum* The ruptured follicle is transformed into a yellow body known as the *corpus luteum*. Not only is the appearance of the follicle altered, but there is, at the same time, a change in the nature and character of the internal secretion produced by it. It no longer secrets the follicular hormone (estrin), but a new hormone with completely different action is now produced. The hormone secreted from the corpus luteum is called the *progestin*. The function of this hormone is to prepare the uterus or the womb for the reception of the fertilized ovum. If conception occurs, the corpus luteum persists; but if there is no pregnancy the corpus luteum rapidly disappears.

(*c*) *Control of Menstruation by the Ovaries* The menstruation in woman depends on the hormones of the ovary. If both ovaries are removed, there results a complete cessation of menstruation, which may be re-established by grafting an ovary under the skin.

Menstruation represents the failure of conception and a step in the preparation for a new ovum and a new possibility of pregnancy. The follicular hormone produces growth of the inner layer (endometrium) of the uterus, as a preliminary preparation for the reception of the ovum. By the 14th to 16th day of men-

struation the follicle bursts, the ovum is expelled; and the follicle is changed into the corpus luteum secreting a new hormone. Under the influence of this corpus luteum hormone the final preparation of the inner lining of the uterus for the reception of the ovum becomes complete. The bed is now ready.

If the ovum fails to embed in the uterus, there will be no pregnancy. In such case, the corpus luteum in the ovary disappears and, as a result of the withdrawal of the corpus luteum hormone, the newly formed thickened inner coat of the uterus degenerates. The interior of the uterus becomes denuded of its covering, resulting in a large wound surface from which bleeding takes place. This periodical bleeding from the uterus is known as the menstruation. The bleeding continues for about four days.

The cycle begins again with other follicles in the ovaries assuming importance.

Menstruation thus represents a failure of impregnation and has been described in a poetic language by some as the uterus weeping for the lost ovum.

The menstrual cycle thus consists of (*i*) Rupture of the follicle and expulsion of the egg and transformation of the follicle into the corpus luteum. For about fifteen days the corpus luteum continues to act, stopping further expulsion of eggs and helping in the preparation of the bed in the uterus for the ovum which had already come out of the ovary. The ovum, however, fails to embed. Corpus luteum degenerates. (*ii*) Bleeding from the uterus takes place as a result of destruction of the newly formed bed for the egg. (*iii*) New follicles and eggs now begin to develop. This period occupies about ten days and is followed by the first period described above.

Pregnancy and the Ovaries

When the ovum combines with a sperm and becomes embedded in the uterus, pregnancy results. When conception takes place the corpus luteum does not disappear but persists and continues to secrete its peculiar hormone. By its action the inner coat (endometrium) of the uterus becomes changed into the "decidua" for support of the fertilized egg until the foetus no longer needs sustenance from it. The corpus luteum prevents the ripening of the follicles and also further expulsion of eggs from the ovary, thus helping in the undisturbed development of the foetus.

Relation between the Ovaries and the Uterus

From the time of puberty periodic changes take place in the ovaries and the uterus, until 45 or 50 years of age. The cyclic changes in the ovary consist of ripening of the follicles, expulsion of the ova of eggs and formation of the *corpus luteum;* while in the uterus structural changes, which accompany the menstrual cycle, consist of the growth of the inner mucous coat followed by its destruction with bleeding (menstruation) and a period of rest. There is thus an intimate relationship between the periodic changes in the ovary and the uterus.

Result of Disorders of the Ovaries

In a normal woman the ovaries act normally. Excessive or deficient action of the ovaries is injurious to health.

(1) *Before Puberty*

The results of over action and deficient action of the ovaries before puberty are given below. The effects of the absence of the ovaries have been studied after the removal of these glands by operation.

Over actio	*Deficiency or absence of action*
Precocious development of sex characteristics and sexual desire, namely	(*a*) Immature development of sex characteristics, namely -
(*i*) Early growth of breasts.	(*i*) Failure of growth of the breasts.
(*ii*) Early appearance of hair in the pubic region and armpits.	(*ii*) Hair in the pubic region and arm pits fail to develop.
(*iii*) Early menstruation.	(*iii*) Menstruation fails to begin at puberty or becomes irregular.
	(*iv*) Uterus undeveloped.

(*b*) Obesity—deposit of fat under the skin.

(*c*) Tall, slender skeleton.

(2) *After Puberty*

The results of the absence of ovaries have also been studied in women whose ovaries had to be removed by operation for some disease. When the period of maturity is reached, the changes produced by the removal of both ovaries are not so extensive. The symptoms are almost similar to those which appear normally in women at the age of 45 to 50 during cessation of menstruation and the end of active sexual life.

Excessive Ovarian Secretion	*Absence of Ovarian Secretion*
leads to —	(result of castration of the ovaries) leads to
Profuse menstruation .	Cessation of menstruation.
Increase of sexual activity.	Emotional disturbances, such as irritable temper, depressed and sad feeling, sensation of hot flushes and pains in various parts of the body, fainting sensation, etc.

Deficiency or Absence of Ovarian Hormone

Infantilism

At the time of puberty, a girl, who has not differed much from a boy of similar age becomes transformed into a woman. When, however, for some reason or other the ovaries fail to exert their influence before puberty, the appearance of the girl does not change with age. This abnormal condition is known as Infantilism.

The cause of Infantilism is great insufficiency or a total absence of the follicular hormone of the ovary.

(*a*) Absence of ovarian hormone—

In some cases there may be a defect in the development of the ovaries from birth and these glands have never given evidence of their power. Rarely ovaries are removed by operation for tumour, etc., with the result that the body does not get the benefit of the hormones at puberty.

(*b*) Insufficient secretion of the ovaries—

In most cases the ovaries are injured as a result of infectious diseases, such as syphilis, etc., and fail to exert their proper function. In the case of primary ovarian deficiency, the body gets little or no follicular hormone. The anterior pituitary hormone, the controller of the ovaries, may be over-active in such cases; but as the ovaries are diseased the anterior pituitary hormone cannot exert their action.

Deficiency in secretion of the ovaries may also result from low activity of the anterior pituitary. In these cases the ovaries are all right, but cannot act for want of stimulus from the anterior pituitary hormone.

Symptoms

When the ovaries fail to exert their influence at puberty, the usual transformation of the girl into a woman cannot take place.. The breasts remains like those of a little girl or boy and the pubic and axillary hairs fail to develop. Menstruation may be entirely absent or is scanty and irregular.

Certain changes occur in appearance of the girl. Normally at the age of 14 or 15 the epiphysis and diaphysis of the long bones unite, as a result of the action of the ovarian hormone. So normally there is practically little growth in the long bones after puberty. But, where the ovarian hormone is absent, the long bones fail to unite at puberty and continue to grow under the influence of the anterior pitutary hormone. There is thus increased growth of the lower limbs with the result that the lower portion of the body becomes longer than the upper, like that of an eunuch. The uterus remains like that of a little girl.

Treatment

In treating cases of infantilism it is at first necessary to consider whether (*i*) the deficiency is primarily in ovarian hormone; or (*ii*) it is secondary to defect in the motor of the sexual organs—the anterior pituitary.

Where the ovaries themselves are at fault it is necessary to replace the deficient follicular hormone (estrin). This hormone is also the general growth

hormone for the entire female genital system and therefore it comes to have a great importance for the development of the secondary female characteristics, particularly the breasts. If the case is seen early the use of estrin has been found to promote feminine development.

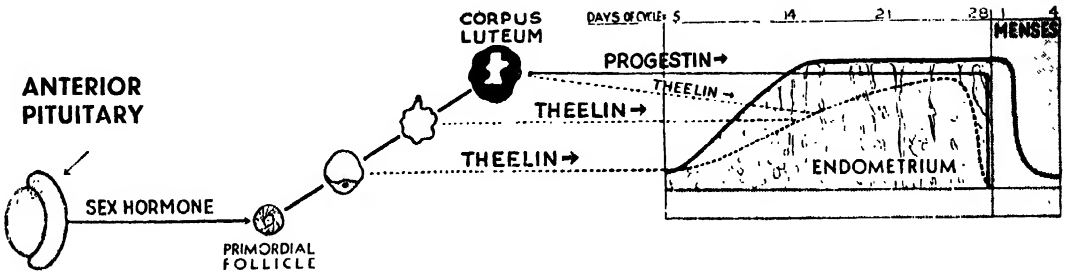
Inactive ovaries may sometimes be stimulated by X-ray. Ten per cent of the dose producing redness of the skin is the safe limit. Exposures are given every fifth day and continued only for two weeks. Only three exposures in all are thus given. It should be remembered that there is danger of damage to the ovaries even under such mild exposures and none but expert radiologists should be allowed to undertake X-ray treatment.

uterus is damaged beyond repair, menstrual flow may be established again by injection of this hormone.

(*b*) In some cases the anterior pituitary and the ovary are both defective. The patient shows signs of deficiency of anterior pituitary hormone and this hormone is absent in the urine. In such cases it is reasonable to give both anterior pituitary hormone and estrin. The object is to stimulate the slowly maturing follicles into increased activity and to supply the deficient hormone.

Artificial Menopause

In women menstruation ceases for good at the age of 45 to 50. This is known as the menopause. In case of removal of the ovaries by operation after puberty



A diagrammatic representation of the development.

Ovarian Deficiency

A slender delicate emotional woman with delayed development of feminine characteristics and deficient or lacking menstruation—these are the characteristics of ovarian deficiency.

Menstruation depends, as we have seen, on the activity of the ovarian hormones. If the ovaries be defective, there is atrophy of the inner coat (endometrium) of the uterus. As a result of this, the menstruation is either stopped or becomes scanty and the woman becomes sterile.

Treatment

In these cases too, the treatment depends on whether the ovaries, anterior pituitary or both are deficient.

(*a*) In primary ovarian deficiency—

Where the ovaries are defective estrin is given as substitution treatment. Unless the inner coat of the

symptoms similar to those at menopause occur. Menstruation ceases and the patient complains of headache, fainting, feeling of heat etc.

Treatment

In cases of artificial menopause, estrin should be used as replacement treatment. There is relief of symptoms and menstruation may also be produced. Cases which have been treated with estrin have shown an abatement in vasomotor and nervous symptoms.

Excessive Action of the Ovaries

An over secretion of the ovarian follicular hormone is also harmful.

Causes

An over-production of estrin is generally due to infections or malposition of the uterus.

In some cases it is the result of deficiency in anterior pituitary hormone. Owing to want of sufficient

stimulus from the anterior pituitary, the maturing follicles in the ovaries fail to rupture and expel the ova. As the follicles do not burst, no corpus luteum can be formed. Consequently the follicles continue to enlarge and the continued production of estrin from the non ruptured follicle keeps the inner coat of the uterus in an over active phase, leading to bleeding.

Symptoms

The local effects of excessive ovarian secretion may be seen in more *profuse and protracted menstruation*, lasting for 8 or 10 days or more. It is seen in many cases in girls about and just after puberty and in women in whom the correlation of the internal secretions in regard to the altered conditions have not been finally adjusted. In cases where it occurs at the period of puberty, the first menses are precocious and plentiful, last from 8 to 10 days and reappear at each period with the same characteristics. This excessive menstruation may be explained by the fact that the ovaries have a direct bearing upon the inner coat of the uterus producing congestion of blood. Such excessive menstruation may lead to anaemia.

An excessive ovarian secretion leads to an increase in sexual activity. These women are generally coquettish and seek male companions. They are sometimes found to resort to masturbation and other sexual perversions.

Treatment

In excessive menstruation at puberty, the anterior pituitary hormone has been used with advantage in some cases. Bleeding at puberty is in most cases due to the unopposed action of follicular hormone of the ovaries (estrin) as a result of deficiency of the anterior pituitary sex hormone. The injection of anterior pituitary hormone will supply the necessary stimulus to the ovary. The object is to convert a persistent follicle into a corpus luteum. Large doses of anterior pituitary hormone are therefore required. The treatment should be continued until the flow becomes normal.

In cases of excessive or prolonged menstruation of young women, good results may often be obtained by using corpus luteum hormone in conjunction with anterior pituitary hormone. The object of giving anterior pituitary is to stimulate the ovary to cause expulsion of ova and thus lead to formation of corpus luteum which will in its turn check the bleeding. The advantage of the antagonistic action of the corpus luteum hormone may also be taken.

Relation of the Ovaries with other Glands

Anterior Pituitary - The anterior pituitary secretion contains two important hormones controlling the activity of the ovaries. One of the hormones in the anterior pituitary secretion stimulates the ovarian follicles leading to the production of estrin. This is known as the follicle stimulating hormone (*Prolan A*). The other factor (*Luteinizing*) hormone in the anterior pituitary secretion causes transformation of the follicle into a corpus luteum. Ovulation is probably due to a balanced action of the follicle stimulating and luteinizing hormones at a definite stage of follicular growth.

Thus the hormone of the anterior pituitary and the ovaries are interdependent in their action. The cycle may be described diagrammatically as follows:

Anterior Pituitary.	Follicle stimulating hormone (Prolan A)	Luteinizing hormone (Prolan B)
	↓	↓
Ovaries	Ovarian follicle =estrin	Corpus luteum Progestin
	↓	↓
Inside coat of the Uterus.	Preliminary preparation of the uterine mucosa for the reception of the ovum.	Formation of the bed for the foetus (decidua) if pregnancy occurs.

Posterior Pituitary -The hormone of the back portion of the pituitary gland produces contraction of the uterus in women. There is an antagonism between the internal secretion of the posterior pituitary and that of the corpus luteum. During pregnancy, the corpus luteum dominates the scene and the action of the posterior pituitary hormone in causing contraction of the uterus is kept in check. At the end of pregnancy, however, the corpus luteum degenerates. Then the pituitary hormone gets an opportunity to act on the uterus and brings on labour pain.

Thyroid - The thyroid plays some part in the production of sexual characters in both sexes. Puberty and menstruation do not take place, as a rule, in women with inactive thyroid glands. In a cretin the ovaries are ill-developed with infantile uterus.

Graafian Follicle Hormone—Estrin

Estrin is the name given to the hormone secreted by the follicles of the ovaries. It is so called because of its power of promoting heat (Oestrus) in animals.

When this hormone was first discovered it was named Folliculin. It was also called Theelin, a name derived from thelu, the Greek equivalent for the female sex.

Nature of the Hormone—Estrin has been isolated and prepared chemically. The chemical formula of estrin is $C_{18}H_{22}O$. It is interesting to note that crystalline testicular hormone has the formula of $C_{18}H_{22}O_2$. Estrin is soluble in water. It is stable towards heat and cold; and treatment with acids and alkalies does not injure it.

The hormone capable of producing heat in animals was first isolated from the ovarian follicles by Doisy. This hormone has now been found to be a dihydroxy form of estrin (œstradiol). In this form it circulated in the body.

Subsequent tests disclosed the presence of this hormone in the urine of pregnant women and in great abundance in the placenta and the amniotic fluid. Estrin is present in the urine of pregnant women in the proportion of 1: 1,000,000. Beginning with the second month of pregnancy there is a constant increase of estrin in the urine, and it then completely disappears by the tenth day after delivery. This hormone is identical in activity to that found in the ovarian follicle: but chemically it is a keto form of follicular hormone. Hydroxy-ketonic form of estrin (Oestrone) has been found to be the excretion form of the hormone.

Method of Preparation—Estrin may be prepared from the urine of pregnant women; but as it is present in such a minute proportion (1: 1,000,000) one can imagine the huge volume of urine of pregnant women that is necessary for its preparation. Recently the urine of pregnant mare has been found to be a much richer source of estrin than any other hitherto available.

The usual method of isolation of estrin is to extract acidified urine with a lipoidal solvent(such as ethyl acetate), and then remove it from the solvent with dilute caustic soda. Further purification depends upon solution in benzine, ether and ethyl acetate.

Preparations of Estrin Estrin is available in three forms—hydroxy-keto form, di hydroxy form and tri-hydroxy form.

(1) Ketohydroxy-estrin (Oestrone) It is an excretion form of the hormone, and is prepared from the urine or amniotic fluid of pregnant cattle. It has been adopted as the standard in the assay of the preparations of estrin by the League of Nations. The preparation sold under the trade name of Theelin belongs to this group. Theelin in oil is available in two strengths 2,000 and 10,000 international units per c.c. The advantage of an oily preparation is that it may be given in larger doses than an aqueous solution.

(2) Di hydroxy estrin (Oestradiol)—It is the actual sex hormone which circulates in the body. The preparation known as Progynon B is the benzoic acid ester of di-hydroxy estrin. Progynon B in oil is available in two strengths -10,000 and 50,000 international units per c.c. The usual dose is 2,500 I. U.

(3) Tri-hydroxy-estrin (Oestriol) If two hydroxyl groups are added, the resultant compound is tri hydroxy estrin. Its activity is less than that of the other forms, but it has an advantage over them in that it may be taken with benefit by mouth. The preparation known as Theelol belongs to this group. It is available as capsules. Each capsule is equivalent to 200 I. U.

Method of Testing Potency The potency of a preparation of estrin is tested by its power of inducing the ovarian cycle in an adult female rat the ovaries of which had been previously removed. Menstruation in women and œstrus in rodents like the rats have certain features in common, though they are not the same phenomena. It has been found that synchronously with the cyclical changes in the ovaries, there occurs cyclical changes in the uterus and vagina. During œstrus there is growth of cornified cells in the vagina, and the vaginal secretions, if examined at this stage, show these cells. Castrated animals can have no ovarian cycle and their vaginal secretions show cornified cells. But when estrin is administered to a castrated

animal it supplies the deficiency and thus induces ovarian cycle though the ovaries had been removed. As a result of this, cornified cells appear in the vaginal secretions of the animal.

The least amount of the estrin that will produce cornified cells in the vaginal secretions in the adult castrated female rat is known as the rat unit. An international unit has now been adopted by the League of Nations. The method suggested by the League is also based upon the changes in the vaginal secretions produced by the subcutaneous injection of a given dose of estrin into castrated adult female rats. The standard adopted is a quantity of pure crystalline keto-hydroxy estrin, which is preserved at the National Institute for Medical Research, London. The unit of activity is taken as the specific power of inducing œstrus of 0.0001 mg. of this preparation. One rat unit previously used as a standard is equivalent approximately to 8 international units.

The potency of estrin is determined by administering it to rats previously deprived of their ovaries, and by determining the changes that occur in the vaginal secretions during œstrus. Vaginal smears are taken once a day and examined under the microscope for the presence of cornified cells.

Determination of estrin in the urine—The quantity of estrin present in the urine of a woman is the best method of determining the activity of the ovaries. A normal woman excretes throughout her menstrual cycle 10 to 20 rat units of estrin per litre of urine. The estrin in the urine may be determined by the method of Kurzro and Ratner based on a method of obtaining crystalline hormone.

Action of Estrin—Estrin plays a great part in the development of the secondary sex characters. It stimulates the growth of the breasts. It also produces changes in the inner coat of the uterus.

The Results of Over or Under-Secretion of Estrin

1. *Deficiency of Estrin*—Deficiency or absence of estrin before puberty may lead to under development of the secondary sex characteristics and lack of menstruation. The ovaries may be primarily at fault or the deficiency may be due to want of stimulus from the controller of the internal secretions of the ovaries—the anterior pituitary.

If the ovaries are removed by operation or rendered inactive by X-ray exposure, menstruation stops for good and certain peculiar symptoms such as hot flashes, sleeplessness, melancholia etc. may arise. In these cases no estrin is found in the blood or urine of the patient.

2. *Over-production of Estrin*—Patients suffering from excessive bleeding during menstruation frequently have excess amounts of estrin. In some cases of bleeding at puberty, the cause is unopposed action of estrin as a result of deficiency of anterior pituitary hormone.

Uses of Estrin

As estrin promotes feminine development and is a factor in the promotion of the menstrual cycle, it is used in cases of genital under development and deficiency in menstruation.

In women with under developed breasts and infantile uterus, the ovaries or the anterior pituitary or both may be at fault. Where the defect lies primarily in the ovaries estrin is given to supply the deficiency in this hormone. In some cases there are associated signs and symptoms of anterior pituitary deficiency. In such cases both the ovary-stimulating principle (anterior pituitary hormone) and estrin should be given. The object of administration of anterior pituitary hormone is to stimulate the slowly maturing follicles into increased activity.

In cases of lack of menstruation (amenorrhœa) due to atrophy of the inner coat of the uterus resulting from failure of ovarian secretion, the administration of estrin has been found to be beneficial. Unless the atrophy of the inner coat of the uterus is too far advanced, the menstrual flow may reappear.

The troubles which appear after the removal of the ovaries can very often be obviated by giving estrin.

Corpus Luteum Hormone—Progestin

The corpus luteum is an accessory gland concerned with pregnancy, formed inside the ovary. It secretes a hormone known as the Progestin or Lutein. It was named Progestin on account of its action in preparing the uterus for conception and maintaining preganacy *i.e.*, gestation.

Progestin was first obtained from the corpus luteum by Corner and Allen. It was prepared in crystalline

form from natural sources by Slotta and by Buttenandt. Shortly afterwards it was also prepared artificially from pregnandiol, a sterol occurring in pregnancy urine and also from stigmasterol from soyabean. Pure crystalline corpus luteum hormone has been named Progesterone and is prepared in the form of needles. It is closely related chemically to estrin.

Method of Testing Potency The assay is based on the degree of proliferation produced in the inner coat of the uterus of the rabbit. This can be applied to the female rabbit deprived of the ovaries after coitus or to the immature female rabbit after treatment with estrin.

Preparations—Corpus luteum harmone is now available under the trade names of Gestone (Payne and Byrne), etc. Gestone ampoules contain 1 or 2 international units of progestin.

Action—The Corpus luteum hormone supplements the action of the follicular hormone (estrin) by further changes in the inner coat of the uterus. It causes branching of the glands in the mucosa with deep embedding. These changes are necessary for the implantation of a fertilized ovum. If a fertilized egg does arrive, the corpus luteum persists and continues to support the decidual endometrium until the inhabitant no longer needs sustenance from it. So progestin is a synergist in the fact that it finishes the uterine cycle begun by estrin.

Should conception take place, persisting corpus luteum inhibits further ripening of follicles and its output of estrin. Progestin thus acts as an antagonist of estrin this manner. In addition to this the corpus luteum hormone also helps the growth of the secretory system in the breasts.

Relation between the follicular and corpus luteum hormones is expressed below:

Action on.	Estrin.	Progestin.
Uterus	Produces proliferative changes in the endometrium of the uterus.	Acts upon the endometrium built up by estrin; prepares it for implantation of the fertilised ovum.
	Excites uterine contraction.	Inhabits contraction of the uterus and thus prevents premature labour.
Ovaries	....	Prevents further expulsion of ova in case of pregnancy.

Disorders of Corpus Luteum If the corpus luteum fails to rupture in time the result would be long intervals between the menstrual periods. Once the corpus luteum ruptures the stimulus to menstruation is liberated and the flow starts.

Excessive menstruation of young women may be due to the failure of the follicle to rupture and form a corpus luteum. The continued production of estrin from the non ruptured follicle keeps the inner coat of the uterus in an over active state which bleeds. This phase is not supplanted by the formation of the bed for the foetus because of absence of corpus luteum formation.

Some cases of sterility in women are due to the disorders of the corpus luteum. These women menstruate reguarly, but still do not bear any child. The cause is probably the failure of the corpus luteum to bring about changes in the inner coat of the uterus preparatory to implantation of the placenta.

Uses of Progestin In treating cases of excessive or prolonged bleeding during menstruation caused by over action of the estrin, advantage may be taken of the antagonistic action of the progestin.

Habitual abortions not due to organic diseases may sometimes be prevented by the use of progestin injected under the skin.

Sterility in women menstruating regularly may be treated with the corpus luteum hormone.

RESEARCH NOTES

Optical Harmonic Analyzer

A periodic function is often conveniently represented by a Fourier Series. The actual harmonic analysis of such a Fourier Series is often very troublesome and generally some mechanical device is adopted to analyse the Series. An Optical Analyzer with simple automatic control measuring as many as thirty harmonics in a minute and a half has been reported to have been perfected by H. C. Montgomery of the Bell Telephone Laboratory (*Bell Sys. Tech. J. 17*, 406, 1938.)

The principle underlying the method is quite simple. As is well known, the co-efficients of the terms in a Fourier Series are expressed as integrals over one complete period, of the product of two terms—the function f(x) and a sine or cosine term of the form sin nx or cos nx.

f(x) and cos nx are recorded on photographic films by either the variable area or variable density method. If two or more such records are superposed, the light transmitted through the combination will be proportional to the product of the functions provided, of course, not more than one of them is of variable area type. A cos nx term can be converted to sin nx by shifting the corresponding record through a quarter of a wave-length. A measure of the intensity of light transmitted through the combination enables one to calculate the various co-efficients—the cos nx record being moved in different position to get the different co-efficients. To analyse a function f(x) into various harmonics we require as many different cos nx records.

The experimental arrangement of the optical harmonic analyzer is as follows:—Light from a strong source is condensed by a system of lenses on the f(x) record and the image is magnified by another system of lenses. The cos nx record is moved at the required rate in front of the magnified image of f(x) by mechanical arrangements. The light after passing through the combination is focussed by a lens on a photocell. The variations in the photocell output are recorded by an instrument similar to a high speed level recorder differing from it chiefly in having a linear instead of a logarithmic scale.

The instrument designed as described above can analyse records of f(x) which are from "$\frac{1}{10}$ to $\frac{3}{10}$" long and not higher than their length *i.e.*, analysis can be made upto the 30th harmonic approximately.

The records of the optical harmonic analyzer agree quite closely with those of other mechanical analyzers and the measurements of the former are done far more rapidly and conveniently.

—*A. K. B.*

Purine Synthesis in Mammalian Metabolism

Nothing definite is known about the precursor of the purine nucleus as synthesised in mammalian metabolism. Ackroyd and Hopkins showed that the removal of arginine or histidine from diet diminished the excretion of allantoin by 40 to 50%. The high content of arginine in placental protein suggested this amino-acid as the important precursor for the embryo. Harding and Young fed placental and meat proteins to puppies and found that more allantoin and uric acid were excreted on the placental diet. Rose and Cook, from their experiment with rats concluded that histidine and not arginine act as the mother substance of allantoin. But György and Thannhauser (Hoppe—*Seyl. Z. 180*, 286) failed to detect any influence of added histidine on the excretion of uric acid in infants of 4 to 8 months fed on milk and casein free from arginine and histidine.

RESEARCH NOTES

Crandall and Young (*Biochem. J.* 32, 1133, 1938) attempted to contrast for the puppy the metabolic effects of synthetic diets, high and low in arginine and histidine, and to determine whether the level of purine excretion could be related to the level of ingestion of histidine or arginine.

Three mongrel puppies 4-8 weeks old were confined in metabolism cages, the urine was collected under toluene in 24 hr. periods and its total nitrogen was estimated by the Kjeldahl method, creatinine by Folin micro-colorimetric, uric acid by Christman and Ravwitch and Allantoin by the method of Larson. Regarding diet the basal requirements of Cowgill was followed, supplemented by yeast concentrate, halibut liver oil, salt mixture and bone ash.

From the results of their experiment the authors conclude that the excretion of uric acid and allantoin in the puppy is dependent upon the type of protein in essentially purine-free diets containing a single protein. Haemoglobin, high in histidine, causes the largest excretion and arachin, high in arginine, the lowest .

It is suggested that the conversion of histidine into purines by the puppy occurs in excess of anabolic needs and is demonstrable by increased urinary excretion of uric acid and allantoin, dependent upon the type of dietary protein.

- *H. N. B.*

Unique Electrically Recording Foucault Pendulum

In an unoccupied elevator shaft at Mundelein College for Women, Chicago, a Foucault pendulum is being installed, by which rotation of the earth on its axis may be demonstrated and measured. Swinging nine stories, the pendulum is 120 feet long, the longest of its kind in existence and the only one of its kind, so far as is known, to have its movements recorded by an electric spark.

The suspension consists of two cylinders at right angles, rolling on flat surfaces. It is a device credited to Alaeine Cummings Longdon, of Knox College. The pendulum ball, which swings in the pit 120 feet below the suspension, is supported by wires from the upper cylinder. The contact surfaces are hardened and polished, resulting in very low friction.

Recording of the azimuth of the swing is by means of a spark discharge which punctures a coated paper disk, eight inches in diameter, on a suitable table below the pendulum. The table holding the paper disk is made of hard rubber, 12 inches in diameter, supported by a tripod casting. A brass ring about 8.5 inches in diameter is inlaid in the top surface and is connected to a terminal below.

A high voltage transformer is connected between this terminal and the ground. Thus as the pendulum swings across the ring, a spark jumps between the ring and a platinum point on the ball. The coated paper on the ring is thus marked by the spark flashing through it. The brass ring is graduated in degrees to read the angular position of the points on the coated paper.

- *Scientific American*

University and Academy News

National Academy of Sciences, India
(Allahabad, 25th August, 1938)

(1) "The Mathematical Theory of a New Relativity (Generalised Gravitation)," by the Hon'ble Sir Shah Muhammad Sulaiman.

(2) "The Solution of certain types of Differential Equations," by Prof. A. C. Banerji and P. L. Bhatnagar.

(3) "New Avian Trematodes (Family-*Diplostomidae*) from Indian Birds," by R. D. Vidyarthi.

(4) "Tungsten and Molybdenum powder in Organic synthesis," by Gauri Shanker Basu and Dr S. B. Dutt.

(5) Chemical Examination of Indian Molasses Fasel oil from the Patent Still Distillery of Messrs Carew & Co., at Rosa, Shahjehanpur," by Dr S. B. Dutt. Chemistry Department, Allahabad University.

(6) "Cadmium powder as a Synthetic Reagent" by Anil Chandra Chatterji and Shikhibhushan Dutt.

(7) "The Formation of Liesegang Rings in the presence of precipitates," by Binayendra Nath Sen.

(8) "Annotated list of the Helminths recorded from domesticated Animals of Burma," Part I. Trematoda, by R. C. Chatterjee, Rangoon.

(9) "Changes in respiration and H-Ion concentration in Wounded Potato Tubers," by Dr B. N. Singh and M. L. Mehta, Benares.

The Dacca Botanical Society
(Dacca, 1st August, 1938)

(1) Some aspects of Respiration and Respiratory Quotient of Plants by N. K. Chatterji.

(2) A Note on the study of *Sclerotium oryzae* by S. Hedayetullah and S. P. Ray Chaudhuri.

(3) Utility of a planned Garden attached to Schools in Bengal by P. N. Mazumdar.

Indian Physical Society
(Calcutta, 27th August, 1938)

(1) Theory of absorption in Ionised gases - Part II. Optical properties of liquid metals (Com. by Dr R. C. Majumdar) by Mrs B. Majumdar.

(2) Dissociation in Sulphuric Acid with temperature (Com. by Dr I. R. Rao) by P. Koteswaram.

(3) Structure of aromatic compounds IV, Space Groups and Atomic arrangements in Phloro-glucine di hydrate by K. Banerji and R. Ahmad.

(4) On the electronic condition due to '4f' electrons in some trivalent rare earth compounds by K. P. Ghosh and B. P. Ghosh.

(5) Thermal co-efficient of rock-salt by X-ray reflection (Com. by Prof. K. Prosad) by S. Basu and A. T. Maitra.

Also, Dr M. N. Saha delivered a lecture on "Cosmic rays" which was followed by discussions.

UNIVERSITY AND ACADEMY NEWS

Research Work in India

We publish below a short connected account of the researches carried out in the physics laboratory of the Royal Institute of Science, Bombay, during the year 1937-38. It is our desire to publish regularly statements of progress of researches in the different branches of science from the various research centres all over India. These short reviews are expected to be useful for the other research workers in the country and we hope it will prove interesting to our readers, who may pursue the subject of their choice with full details from the respective centres. We invite the co-operation from the various universities and research institutes in the form of reviews of the works done there for use in our columns.

Royal Institute of Science, Bombay (1937-38)

The investigations (during the year 1937-38) related to scattering of light, spectroscopy, and also to some problems of industry and engineering.

Scattering of Light.—The nature of light scattered by a cloud of drops much larger than the wave-length of light has been investigated both experimentally and theoretically, extending in the latter case, Mie's theory to drops considerably larger than wave length of light. The dependence of the nature of the light transmitted by a cloud on the wave length of light has also been studied. Technique for the quantitative measurement of intensities of light has been developed, using a photo-electric cell for the purpose, and with the help of this technique, the change of depolarisation of light scattered by gels with the setting of the gels is being investigated.

Spectroscopy.—Band spectra of some molecules in the photographic infra-red region have been studied. Technique has been developed for hetero-chromatic photographic photometry of spectral lines and using this method, experimental investigations have been made on the emission of Swan bands under various conditions of excitation, on the quantum laws governing the distribution of vibrational energy in relation to rotational energy, on the dependence or otherwise of transition probabilities and on the condition of excitation and temperature equilibriums in various sources. By using these methods, investigations have also been made on the combustion in flames and on the ultra-violet content of sunlight at Bombay. Studies in these lines are being pursued with the first positive bands of nitrogen and the relative statistical weights of electronic levels in molecules are being investigated.

Viscosity of gases. An improvement has been introduced in the capillary tube method for the measurement of viscosity of gases and the results obtained with a few gases by this method are in good agreement with those obtained by previous workers using different methods.

Dielectric constant of Liquids. The dielectric constant of a large number of oils has been measured and from these results, the molar and electronic polarisations as well as the electric moment have been calculated.

Problems of Industry and Engineering.—Attempts are being made to investigate whether it is possible to coat silk and cotton threads with silver and gold for industrial purpose. In the preliminary investigations it has been found possible to coat these non conducting surfaces with fast adhering graphite in the colloidal form. These investigations are being pursued using copper and nickel electrolytes in order to coat the surfaces with copper and nickel by the electric method.

Stresses developed in a square metal plate clamped at the boundaries and subjected to uniform pressure over one of the faces have also been successfully worked out.

Book Review

"Table of functions" *by Jahnke and Emde (B. G. Teubner, Leipzig. 3rd edition, 1938: with 181 figures and covering, 305 pages; price, cloth R. M. 15).*

This is a revised edition of that world-renowned book, "*Funktionentafeln,*" first published in 1909 in German language. Since that time it has passed through two revised editions, one in 1933 and the other, the present one, just appeared. Dr Emde is to be congratulated on his publishing the revised and enlarged editions since the death of his collaborator Dr Jahnke in 1921. The English rendering of the subject matter given side by side with the original German has enhanched the utility of the book to the English-speaking countries. The Table contains exact representations of the functions and the perspective reliefs are executed in a remarkably vivid style, so that the applications of the higher functions to actual practical problems leave nothing to be desired, and we have every reason to believe that the Table will serve the purpose of an indispensable *vade-mecum* to the mathematician, the physicist and the engineer. In this new edition the elementary functions, *e.g.*, exponential function, elementary transcendental equations, circular and hyperbolic functions of a complex variable and other topics have been excluded, which were incorporated in its predecessor, and we hope these will be dealt with in a companion volume which, we are given to understand, is to appear shortly. Chapters on confluent hypergeometric functions and Mathieu functions are welcome additions to the topics dealt with in the second edition of this Table. Under complete elliptic integrals formulæ and numerical tables have been added for other than the Legendre standard forms, thus numerical calculations have been much improved. The sections on Bessel functions have been admirably written throughout, and the computations are moderately extensive to suit the volume of such a handy table. A new feature is the complete numerical tables for the Lommel-Weber and Sturve functions of orders zero and one. The Table is devoted to eleven chapters in all and there are various sections under each. The bibliography appended at the end of each chapter will be found very useful to those who wish to learn more about the theories on the basis of which calculations are carried through in this Table. The price of the book is a little reduced from that of its predecessor. The ability, care and patience that have been taken by the publishers to bring out this attractive volume will be amply rewarded if the Table of Functions command a wider sale, thus enhancing the usefulness of the book all over the scientific world.

--*K. B.*

Das Aufbauprinzip Der Technik *by P. Wessel. (Verlag Von Ernst Reinhardt in Munchen. 1937 pp. 39).*

In the introduction the author states how right bodies become the basis of all measurements and how they form parts of apparatus. In the first chapter the author discusses how rigid bodies are deformed to suit the various purposes in modern industry. In the second chapter practical geometry and linear measurement is treated from a basic stand-point. The third chapter deals with the various ideas of assembling different types of instruments, the idea of coupling and construction forming the fundamental of machine practice. This is a very interesting little book of 40 pages, apart from the materials

in the book the general idea and its presentation is indeed very interesting.

—*P. N. G.*

SOCIOLOGY: *A brief outline. By* K. *Motwani. Ganesh & Co., Madras) 1937. Np. 63 and a Bibliography. Price not stated.*

This is a lucidly-written introductory outline to modern Socialogy. Dr Motwani is a scholar with reseach and lecturing record in American Universities. The brochure is the introductory chapter to the second edition of his "MANU: A STUDY IN HINDU SOCIAL THEORY," and deals with the various approaches to the study of the subject and is refreshingly Catholic and up-to-date in attitude and content. It is a good primer for the uninitiated.

B. N. B.

PHYSIK FUR STUDIERENDE AN TECHNIFCHEN HOCHFCHULEN UND UNIVERSITATEN *by Ing. Paul Wessel. (Verlag Von Ernst Reinhardt in Munchen). 1938 page 514 and an index price*

There are numerous text books on the theoretical aspects of Physics, but for the students attending universities or technical colleges there is at present hardly any that would satisfy the conditions required for engineering students. Dr Wessel's book really, therefore, supplies the essential elements of Physics needed for engineers. In the introductory chapter one finds, classification of Physics and systems of measurement. Newton's law is introduced in connection with Mechanics of Solid Bodies. For liquid bodies the propagation of pressure and molecular action is treated in a very simple fashion. For gaseous bodies, the laws of Avogadro and Boyle and molecular effects have been discussed. The second part of this first section is devoted to a study of harmonic motion, sound production and conduction in acoustics, heat and one finds a fairly good chapter on Photometry, the Laws of Reflection, Dispersion, Interference and Polarisation. In section 2 a general account of the magnetic phenomena, the optical effects of magnetic fields, electrostatic field, electric potential and capacity have been discussed. Electronics and electro-dynamics are fairly well discussed including X-rays, Electron beams, Isotope Effects and Atom disintregation. The growing important of this subject for engineering students are being slowly recognised and as such this book will really serve a very useful purpose. The section 3 is really a summary and collected data of the previous sections dealt with in the form of interesting questions covering the entire domain. The last section is that of tables and the selection in a short compass is fairly instructive. Care has been devoted specially to those properties of material which are of importance more to the engineering than to the students of Pure Physics. Though written in German, unless the language problem is note of great difficulty the subject matter and the method of presentation would certainly appeal to all students.

—*P. N. G.*

LETTERS TO THE EDITOR

[The Editor is not responsible for the views expressed in the letters.]

Weather Conditions and Radio Reception at Long Distances

The significant part which weather plays in the propagation of radio waves suggests a relationship between the propagation of these waves and the meteorological conditions. Ranzi[1] finds that the reception also depends much on the conditions of the troposphere. Several investigators[2, 3, 4], studied the effect of the main meteorological conditions, *i.e.*, temperature, pressure and humidity to the received signal. Their results show that the received signal is dependent on the above factors at the receiving end. Schwers[5] and Glover[6] show that the changes in sensitivity at the receiver appear to be highly correlated with humidity in the atmosphere while Stratton[7] has shown that rain and fog have no effect on the propagation of radio waves.

Collwell[8] has shown that the variation in the field strength can perhaps foreshadow weather conditions from twelve to twentyfour hours ahead. His results from a transmitter, 80 miles distant, show that increasing signal after nightfall indicates a tendency towards rain, while decreasing signal showed clearing weather.

But so far as long distances are concerned there are practically no data available which could possibly be the meteorological factors most likely to affect the propagation of wireless waves. In order to determine the probability of these relations a statistical study was made of the daily signal intensities of a distant transmitting station. This material is then utilized to derive information regarding the possible connection of weather conditions on the propagation of these waves. The present note contains the results of the study of the above relations observed continuously for a long time. The receiving system consisted of a sensitive receiver with Wheatstone Bridge system to nullify the action of the local receiver disturbances and to receive the strength due to the transmitting station only. Observations were made on the carrier of the Delhi station of the All-India Radio working on 340m.

It has been found that the rapid fluctuation in signal intensity is greater in winter and on clear nights. From day to day variations, it is concluded that the signal intensity varies inversely as the temperature and decreased with the falling off of the barometer at the receiving station. It is generally found that the falling of the signal intensity indicated the following day as rough and cloudy while a continuous increase showed a clearing weather. These results seem to be different than those found previously by some investigators for short distances.

The author has great pleasure in thanking Prof. P. Dutt, M.A., (Cantab) and Dr S. S. Banerji for the facilities in carrying out the work.

Physics Laboratory,
College of Science,
Benares Hindu University.
2-9-1938.

R. D. Joshi.

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[6] Glover, R. P., *Proc. Inst. Rad. Eng. 18*, 683, 1930.
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Investigations of Vitamin 'C' in Ripe Tomato Juice

The isolation of vitamin C from paprika and its synthesis in recent years have led to an extensive therapeutic investigation of this important substance. Very striking effects of vitamin C in a number of grave diseases like diptheria,[1] pneumonia,[2] mental disturbance,[3] typhoid fever,[4] etc., have recently been reported. For people in health, however, the natural products containing vitamin C have not lost a whit of their popularity.

Amongst various common articles of dietary of the Bengalees tomato is a very good source of this vitamin. The extreme cheapness of tomato has rendered its easy access possible to the rich and the poor alike.

Of all the known vitamins, vitamin C or ascorbic acid has so long been known to be the most susceptible to heat. As our countrymen are generally averse to taking raw tomato, it is worth while to find out the loss of vitamin C in tomatoes when they undergo the usual cooking process practised in Bengal.

LETTERS TO THE EDITOR

In the present paper the effect of temperature as well as dilution of the tomato juice with varying quantities of water has been observed. The stability of ascorbic acid in the juice containing tomato pulps in suspension as well as the juice from which the pulpy matter has been removed by heat coagulation has also been incidentally studied to determine if the pulp has got any stabilizing effect on the vitamin.

Vitamin C in fresh juice and in the juice freed from protein matters by heat coagulation

A few of the tomatoes are washed thoroughly and the adhering water is soaked in a piece of dry cloth. These are then cut into pieces, pressed and passed through twill cloth. 10 gms of the juice obtained, are taken in a beaker with water and centrifuged, and the centrifugate is made up to 100 c.c. It is then titrated against 2·6 dichlorophenol indophenol by the well known method of Harris & Roy[5] as modified by Guha and Ghosh[6] and Ghosh and Guha[7]. Another 10 gms of the juice are taken in a beaker and kept over water bath for a few minutes so that the temperature rises up to 70°C. The proteins are coagulated thereby and it is then filtered through cotton wool. The filtrate is made up to 100 c.c. and titrated against 2·6 dichlorophenol-indophenol in a similar way. The values obtained are given in table No. I.

TABLE I

Ascorbic Acid in mg. per 1 gm. of the juice

	Unfiltered juice.	Filtered juice.	Simple sugars in unfiltered juice.	Other sugars in the unfiltered juice.
Lot I.	0.291	0.285	2.56%	Trace
Lot II.	0.298	0.308	2.53%	
Lot III.	0.327	0.327	2.70%	
Average	0.305	0.306	2.59%	

Effect of heating the pressed juice with different quantities of water both before and after the coagulation of the proteins.

25 c.c. of the press juice are taken in a beaker and boiled for 10 minutes. It is then cooled and centrifuged. The centrifugate is made up to 250 c.c. and titrated in the usual way. The experiment is repeated by boiling 5 c.c. of the juice with 12.5 c.c., 25 c.c, 75 c.c. and 100 c.c. of water respectively and the results obtained are tabulated in table No. II. About 200 c.c. of the original juice are taken in a flask and kept over water bath for a few minutes. The proteins are coagulated and the resulting liquid is then passed through cotton wool so that a clear liquid is obtained. This is also treated as above and the results obtained are given in table No. II.

TABLE II

Ascorbic Acid in mg. per 1 gm.

	Boiled without any H_2O.	Boiled with 12½ c.c. H_2O.	Boiled with 25 c.c. H_2O.	Boiled with 50 c.c. H_2O.	Boiled with 75 c.c. H_2O.	Boiled with 100 c.c. H_2O.
Tomato juice unfiltered.						
Lot I.	0.277	0.270	0.270	0.256	0.250	0.213
Lot II.	0.294	0.294	0.278	0.256	0.238	0.204
Lot III.	0.357	0.345	0.333	0.333	0.307	0.307
Average.	0.309	0.303	0.294	0.282	0.265	0.241
Loss p. c.	..	1.94%	4.88%	8.73%	14.24%	22.01%
Tomato juice filtered after heating at 70°C						
Lot I	0.256	0.256	0.238	0.213	0.137	0.094
Lot II	0.259	0.256	0.232	0.186	0.133	0.095
Lot III	0.270	0.246	0.243	0.185	0.125	0.090
Average	0.262	0.253	0.238	0.195	0.132	0.095
Loss p. c		3.43%	9.16%	25.57%	49.61%	64.50%

Effect of Heating the Juice at Different Temperatures

25 c.c. of the press juice are taken in a beaker and diluted with water and centrifiuged. The centrifugate is made up to 250 c.c. and titrated against 2·6 dichlorophenol indophenol in the usual way. Another lot of 25 c.c. of the juice is taken and kept at a temperature of 40°C for 10 minutes. It is then diluted with water and centrifuged. The centrifugate is made up to 250 c.c. and titrated in the usual way. The experiment is repeated by heating the juice at 60°C, 80°C and at last by boiling at 100°C. The results obtained are given in table No. III.

TABLE III

Ascorbic Acid in mg. per 1 gm.

Tomato juice unfiltered.

	Ordinary temp. 30°C.	Temp. 40°C.	Temp. 60°C.	Temp. 80°C.	Temp 100°C
Lot I.	0.400	0.400	0.400	0.348	0.344
Lot II.	0.408	0.408	0.392	0.392	0.377
Lot III.	0.323	0.323	0.307	0.298	0.290
Average	0.377	0.377	0.366	0.346	0.337

Effect of Cooking the Juice

A few gms of the tomato are washed and made into thin slices. 10 gms of the substance are taken in a mortar with a few gms of Merck's sea sand and 2.5 c.c. of 20% trichoracetic acid. These are then ground with distilled water and centrifuged. The centrifugate is made up to 100 c.c. and titrated as before. The remaining portion is then cooked with necessary ingredients in the usual way, cooled and weighed, and

the weight in gms equivalent to 1 gm of the uncooked juice is calculated. 10 gms of the cooked substance is then titrated as before and the ascorbic acid content of that weight of the substance equivalent to 1 gm of the uncooked variety is attained. The percentage loss of the vitamin C in the process of cooking is calculated from the difference of the two values and the results are given in table No. IV.

TABLE IV

	Ascorbic acid in mg. per 1 gm.	Ascorbic acid in mg. per 1 gm.	Loss percent.
Lot I . .	0.235	0.200	14.89%
Lot II . .	0.271	0.234	13.65%
Lot III . .	0.277	0.231	16.60%
Average . .	0.261	0.222	15.05%

From table I it is evident that vitamin C is not lost in the process of coagulation of the protein. Table II shows that greater the quantity of water added during heating the greater becomes the loss of vitamin C. So in the process of cooking care must be taken to add minimum quantity of water. The best way is to cook without adding any water at all. It is also evident from the table that the loss of vitamin C becomes more prominent in the case of the protein-free juice and this is accelerated by the rise of temperature. Table III shows that only a very small amount of vitamin C is lost by heating. This may be attributed to the fact that some ascorbic acid in the combined state called 'ascorbigen' by Pal and Guha[8] may be present in the juice which breaks up on heating and compensates the loss thereby. Furthermore, it is found from table IV that the loss of vitamin C in the process of cooking is about 15% only.

Our sincere thanks are due to the authorities of the firm.

Biochemical Laboratory,
Bengal Chemical and
Pharmaceutical Works Ltd.,
Calcutta.
16.8.38.

K. L. Das.
H. G. Biswas,

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Notes on the Theory of the Elastic Pianoforte Hammer

The elastic hammer, which is supposed to behave like a hard load backed by a weightless spring, strikes the string at $x=a$: the string under tension T, and of linear density ρ, is fixed at $x=o$ and $x=l$.

If Y_a, Y_1, and Y_2 are the displacements, at $x=a$, $x<a$, and $x>a$ respectively, then we have, in the usual manner,[1] (as $T=c^2\rho$)

$$\left.\begin{aligned} Y_1 &= Y_a \frac{\sinh Dx/c}{\sinh Da/c} \\ Y_2 &= Y_a \frac{\sinh D(l-x)/c}{\sinh Db/c} \end{aligned}\right\} \quad .. \quad (1).$$

where D stands for the operator (d/dt), and $b=l-a$.

The pressure P exerted by the load is given by

$$P = m\,d^2z/dt^2 = T \triangle (dy/dx)_{x=a}$$
$$= Eu \text{ (Hooke's Law)} \quad .. \quad (2).$$

where the displacement z of the hammer is given by

$$z = Y_a + \text{the compression } u \quad .. \quad .. \quad .. \quad (3).$$

Now with the help of Equations (1) and (3), Equation (2) gives,

$$\left.\begin{aligned} &[mD^2 + D.T/c(\coth D.a/c + \coth D.b/c)]Y_a + mD^2u = JD \\ &\text{and} \qquad mD^2Y_a + (mD^2 + E)u = JD \end{aligned}\right\} \quad (4).$$

where $J=mv_0$, v_0 being the velocity of impact.

From (4), we have,

$$Y_a = v_0 1/F(D)$$

and

$$u = T/Ec(\coth D.a/c + \coth D.b/c)DY_a \quad .. \quad (5).$$

where
$$F(D) = D + (D^2\,T/Ec + T/mc) \times$$
$$\times (\coth D.a/c + \coth D.b/c) \quad .. \quad (6).$$

As the hammer strikes near the end, b becomes large compared to a, and we get

Lt. $b > \infty$, $\coth D.b/c = 1$, and
Lt. $a > o$, $\coth D.a/c$ is equal to
$$c/Da\,[1 + (B_1 + L^2)(2\,Da/c)^2 \quad (B_3 + L^4)(2\,Da/c)^4] \quad .. \quad (7).$$

where $B_1 = \frac{1}{6}$ $B_3 = \frac{1}{30}$ are Bernoullian numbers.

With the help of Eqs. (7) and (6), (5) becomes

$$Y_a = \frac{EV_0c}{T}\left\{\frac{e^{\alpha t}}{(\alpha-\mu)^2+\nu^2} + \frac{e^{\mu t}}{\nu\sqrt{(\alpha-\mu)^2}}\sin(\nu t + \epsilon)\right\} \quad . \quad (8).$$

where α, $\mu + i\nu$ and $\mu - i\nu$ are the roots of the cubic:

$$\frac{T}{Ec} D^3 + (1+\rho a/3m+T/Ea) D^2 + D.T/mc + T/ma = 0 \quad .. \quad (9),$$

and are given by

$$\left.\begin{aligned} \alpha &= -\left(\frac{m_1}{m} \cdot \frac{Ec}{T} - \frac{c}{a}\right) \\ \mu &= -\frac{T}{2m_1C} \\ \nu &= \sqrt{\left(\frac{T}{m_1c} - \frac{T^2}{4m_1^2c^2}\right)} \\ \text{and} \quad m_1 &= m + \frac{a\rho}{3} + \frac{Tm}{Ea} = m_0 + \frac{Tm}{Ea} \\ \epsilon &= \tan^{-1}\frac{\nu}{\alpha-\mu} \end{aligned}\right\} \quad (10)$$

When the hammer is hard, *i.e.*, $\epsilon \to \infty$, Eq. (8) becomes the same as given by Kaufmann. The expression for Y_a (Eq. 8) is perfectly general and is free from Kaufmann's assumption for the 'mass correction'. Attempts were also made to study a similar case by previous works[2], but these works have substituted the 'effective mass' of the hammer, that was assumed by Kaufmann, as such for the actual value of the same.

Department of Physics, Burdwan Raj College, Burdwan. Mohini Mohan Ghosh.
August 1938.

[1]*Operational Methods in Mathematical Physics*—Jeffreys, p. 57, 2nd Ed. (Camb.).

[2]*Phil. Mag.* 47, 1141, 1924; *Phys. Soc. Proc.* 40, 29, 1927.

An Anomaly in the Elastic Behaviour of India Rubber

For some time past I have been studying the elastic behaviour of India Rubber, which is very interesting, for, as is now known, it does not behave like ordinary elastic materials. Some recent experiments have shown a great disagreement betwen the values of modulii of elasticity determined by statical and dynamical methods for different loads and at different temperatures. An attempt to idendify the statically and dynamically determined values with the isothermal and adiabatic modulii was but natural. But the results which have been obtained and which will be published shortly elsewhere do not support this view.

In the case of the modulus of rigidity thermodynamical reasoning shows that the isothermal and the adiabatic modulii should be equal, whereas in the case of Young's modulus the two modulii must be different, the ratio depending upon the temperature, co-efficient of expansion and other factors, such as stress, etc. It is found that the dynamically determined values both for rigidity and Young's modulus are about double the statical values for ordinary temperatures. Further, in the case of rigidity it is found that for a given stress when the temperature is increased, the ratio of dynamical to statical rigidity decreases and when for a given temperature the stress is increased, the ratio increases. Thus for example, for a stress of about 4.9×10^6 Dynes cm^2, the ratio decreases from 2.06 to 1.45 when the temperature increases from 0°C to 60°C, whereas for a stress of 11.32×10^6 dynes/cm^2, the variation of ratio for the same range of temperature is from 2.67 to 2.27.

Hindu College, Delhi. A. N. Puri.
22-8-38.

A. N. Puri, *Proc. National Academy of Science*, India, Vol. VII, Part I, 1937.

Fibre Saturation Point of Wood

Moisture is present in wood in three different forms, *e.g.*, (1) bound with the protoplasm of cells, (2) absorbed by cell-walls, and (3) free in cell cavities. On drying wood, the third form of water evaporates first, and then begins the evaporation of the second form. It is at this stage that the wood has the minimum moisture content which is in equilibrium with a saturated atmosphere and is called the fibre saturation point of wood. This critical point of wood has an important bearing on its various physical properties. Thus the strength, shrinkage, and electrical resistance enormously increase, while the thermal conductivity decreases with progressively reduced moisture contents beyond this point. A study of variation of these properties of wood at different stages of drying is obviously interesting, and the curves thereof will have each a sharp break at the fibre saturation point.

The author has had occasion to determine the fibre saturation point of wood by three different methods, namely shrinkage, electrical resistance and thermal conductivity measurements. The details of the work will be reported later, the following giving only a brief survey of the results obtained: -

The specimens selected for shrinkage measurements were rectangular ones 3"×1", and were progressively dried in an electrical oven at 100°C. Both radial and tangential shrinkages were measured at intervals by means of a caliper and the moisture contents noted (computed on weight of dry sample). Tangential shrinkage was always greater than the radial. Shrinkage was plotted against moisture content, and the break at the curve was taken to indicate the fibre saturation point.

Electrical resistance of wood is practically the same until the fibre saturation point is reached. But as drying

proceeds beyond this critical level, the resistance suddenly begins to increase. Observations were made on specimens cylindrical in shape, 2″ long and 1″ in diameter, with the grain running lengthwise. The arrangement of the apparatus was similar to that used by Myer and Rees of Syracuse University with certain modifications.

Thermal conductivity on the other hand decreases with progressive drying of timber. It may be noted that the break in the curve at the fibre saturation point is not so pronounced as in the two preceding cases. The conductivity varies with regard to (*a*) direction of heat flow and (*b*) coarseness of the grain. Longitudinal conductivity is the greatest, then comes the radial, while the tangential conductivity is the least. The specimens used for the purpose of measuring thermal conductivity were some discs 4.7 mm. thick and 50 mm. in diameter. The method of measurements was similar to that employed by Griffiths and Kaye.[1]

The following are some of the results obtained:-

Timber.	*Fibre saturation point of wood as determined by.* Shrinkage % moisture.	Electrical resistance. % moisture.	Thermal conductivity. % moisture.
Shorea robusta (sal) ..	32.1	30.3	27.4
Mangifera indica (mango)	24.3	28.0	26.6
Cedrella Toona (toon) ..	26.4	32.2	28.1
Odina Wodier (jhingan)	29.2	30.6	26.3
Terminalia Arjuna (arjun)	28.6	31.2	24.2
Terminalia Tomentosa (laurel) . ..	26.8	28.3	32.1
Canarium euphyllum (dhup)	30.0	27.4	31.2
Dalbergia latifolia (rose wood)	29.4	32.3	31.7
Chloroxylon Swietenia (satin wood)	27.3	23.4	29.9
Dichopsis elliptica (pali)	23.6	25.7	25.3
Adina cordifolia (holdu)	28.2	24.3	26.5
Bombax malabaricum (semul)	30.3	33.1	26.4
Pinus longifolia (chir)	22.8	26.4	25.1
Juglans regia (walnut)	28.7	30.9	32.3
Boswellia serrata (salai)	26.9	24.7	25.8
Cedrus Deodara (deodar)	23.7	26.8	30.0

It is not intended here to go into the details of the work and the mass of data collected. They will be reported in due course, when an attempt will also be made to account for certain discrepancies in the results given above. The fibre saturation point of the timbers that have been examined lies roughly between 23 to 33 per cent moisture content.

Calcutta. B. N. Mitra.
28-8-38.

[1] *Proc. Roy. So. A.*, *104*, 70, 1923.

A Note on the Estimation of Maleic Acid and Fumaric Acid

Lucas and Pressman[1] have developed a method for the estimation of maleic and fumaric acids by bromide bromate mixture in acid solution with $HgSo_4$ as a catalyst. About 30 minutes were required by them for the completion of the reaction. In view of the long time required for the bromination, it was thought desirable to investigate whether maleic acid and fumaric acid could be estimated in presence of succinic acid by this method. The effect of phosphates was also studied.

The experimental arrangement was similar to that described by Lucas and Pressman[2]. It was found that maleic and fumaric acids could be estimated in presence of succinic acid by this method, and succinic acid did not interfere. When phosphates were present, a large excess of $HgSo_4$ had to be used otherwise low results were obtained. Probably phosphoric acid acts as a retarder to the bromination of maleic and fumaric acid in acid solution. This is contrary to the observation of Szegedy[3] who actually obtained high results in presence of phosphates at *pH* 8.4 H_3PO_4 probably acts as a retarder of the bromination whereas HPO_4'' and H_2PO_4' probably act as accelerators.

A detailed paper is being published elsewhere.

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5-9-38.

[1] *J. Ind. & Eng. Chem.*, *10*, 140, 1938.
[2] *Loc. Cit.*
[3] *Z. Annal. Chem.*, *109*, 316, 1937.

ERRATUM

For formula in Vol IV, No. 2, p. 134, col. 2. l. 4. *read*—

$$\text{Specific gravity} = \frac{W_1}{\left\{ V + (W_2 - W_1) / \begin{matrix}\text{density of}\\ \text{mercury at}\\ \text{the temp.}\\ \text{of exp.}\end{matrix} \right\}} \times \begin{matrix}\text{density of}\\ \text{water at}\\ \text{the temp.}\\ \text{of exp.}\end{matrix}$$

SCIENCE AND CULTURE

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The Automobile Industry

In writing of the automobile industry in India, we write of an industry which is *non est.* But the theme has been provoked by two pamphlets* by Sir M. Visvesvaraya, ex-Dewan of Mysore, which are lying on our table for some time past.

The automobile industry has not a long history behind it. As a matter of fact, it was a little over 50 years ago, in 1886, that Gottlieb Daimler, a German engineer, substituted the horse in an ordinary coach by a petrol engine, and ran the little *oddity* through the streets of Deutz, a small town near the famous city of Cologne-on-the-Rhine in Germany. Then Daimler made a second engine three years later, and fitted it to a bicycle, and ran it successfully. As a writer puts it, "the little machine ran through the streets of Deutz for some time, and snorted its way to a wider publicity, till a French firm thought it profitable to buy the patent rights for the petrol engine and launch the *motor car* on the market. By 1891, the motor car took its place on the road, and gradually pensioned off the old horse from its age-long duty of carrying the man and his luggage on its back ".†

But very few people realize that this invention is as far reaching in its effect as the substitution of the old beast of burden, the ass, prevalent amongst ancient people, by the horse about the twelfth century B.C. As archaeologists can testify, the horse not only made communication quick, but many a famous struggle in history was decided by the superiority of the horse-arm of the fighting force. It was the superiority of the cavalry which enabled the Parthians about the first century A.D. to roll up the Roman legions from Mesopotamia and cry a halt to the progress of Roman Imperialism to the East. It was superiority in horsemanship which enabled the Tartar nomads under Chenghiz Khan to dominate the greater part of the Old World from China to the confines of Western Europe. It was again a clever use of shock tactics by Mohammed Ghori of the cavalry arm of his army which broke the Hindu ranks and led to Turkish conquest of India.

It is not usually realized, particularly in this country, which looks up to the bullock cart with

* *Proposals for an Automobile Factory in Bombay.* Note I and Note II (confidential) by Sir M. Visvesvaraya, Bangalore.

† *The Book of Knowledge*, page 4319.

wistful eyes, that the motor car is repeating history at the present times in social and political matters, much as the horse did throughout the last three millennia. The cheap motor car, the introduction of which is largely to the credit of Henry Ford has worked out a silent social and economic revolution. It has brought in Europe and America the country to the city and the city to the country, thus restoring the equilibrium between rural and urban life. It has supplemented the means of transport, bringing modern commodities within easy reach of everybody. In Europe and America, it has become one of the basic needs of the family, next to food and clothing, and sometimes it even takes precedence to housing.

But its part in contemporary making up of history is not as widely known as it ought to be. According to competent military authorities the great German thrust to Paris in 1914, was rolled up because General Gallieni, the defender of Paris, mobilized the motor cars and lorries of Paris, and rushed reinforcements to the front. The success of Germany in the recent diplomatic deals is largely due to the strength of her motor-arm. She has constructed over 5000 miles of first class motor roads (auto-strades) which enable her to convey millions of troops within a short time from one frontier to another. By judicious State enterprise, she has forced up the production of motor cars from 46000 in 1931 to over half a million in 1937. But for the strength of the motor-arm, which has been achieved only since 1934, the spectacular diplomatic victories of Germany of recent times would have been impossible. Further it is well known that the motor car has given rise to 'oil-politics'--the scramble amongst the Great Powers for the possession or control of regions yielding petrol—which is largely behind the complicated diplomacy of the last twenty five years.

Development of Motor Car Industries in Europe and U.S.A.

According to statistics compiled by Sir M. Visvesvaraya, if we take the motor car industry as an index of civiliz d existence, the U.S.A. stands easily first, with over thirty million cars in use; about one man in five has a car *i.e.*, every family possesses a car. The corresponding figures for other countries are one for every 18 persons in Great Brittain, one for every 19 persons in France, and one for every 64 persons in Germany (this seems to be a considerable under estimate); in India, there is one car for every 2300 persons. This figure gives an appalling picture of the low index of civilized life in India, but this index is supported by corresponding figures in the amount of electric power developed, and in the number of radio receiving sets used. The U.S.A. manufactures each year nearly five million cars, and pays nearly 330 crores in wages alone. It is estimated that one person in seven in the U.S.A. ekes out his income out of the motor car industry in one way or the other.

The development of the motor industry has been largely due to private enterprise, and it is therefore no wonder that only such countries have been in the forefront where there is plenty of room for private initiative and no dearth of private capital *e.g.*, U.S.A., France and Great Britain. Even Germany, the country of birth of the motor industry, was backward in motor production, though there was no dearth of technical knowledge because State enterprise there had largely usurped the power of private initiative, and large-scale financing was difficult. This weakness in Germany's position was clearly recognized by the Nazis who, as mentioned before, since their accession to power in 1934, have forced up the production of cars almost ten times by large-scale planning, by subsidies to companies and protective tariffs. Since 1934, tariff in Germany on foreign cars has been 80%, and there has been no inland excise on German made cars. Government gives special aid to factories which manufacture for export by subsidising to the extent of 25%. It is stated that it is next to impossible to buy a foreign made car in Germany.

We learn further from these pamphlets that 'Cheap Cars for All' is the latest watch-word in Nazi Germany, which is contemplating the introduction of a People's Car, for the use of people with a monthly income of Rs. 175/- p.m. Germany is dependent for motor fuel on foreign supplies. She is trying to remedy this situation by the production of synthetic petrol, use of compressed gas-fired engines, and has largely succeeded in her effort.

THE AUTOMOBILE INDUSTRY

How Motor Car Industry can be developed in India

It is clear from what has been said before that the development of the motor car industry is one of the prime needs of India. It will not only give employment to a large number of people, but will form a formidable arm of defence, a matter which ought to receive more serious attention in view of the rapidly changing political conditions around our country. At present, India imports nearly thirty thousand cars and lorries annually, and pays nearly four crores to the foreign manufacturer. The price of a car which costs Rs. 3,200/- at Bombay is made up of Rs. 1,260/- to the manufacturer: freight, insurance, import duties, port charges, etc., altogether Rs. 1,130/-, and profit to the agent Rs. 810/-. It is therefore clear that if for a time, the Government gives protection to home-made cars, they can be sold at comparatively cheaper price and India will soon have one of the basic industries, giving employment to millions of people.

Sir M. Visvesvaraya has worked out in the pamphlets before us, a complete scheme of starting an automobile factory in India, turning out about twelve thousand cars annually. It is a very sound scheme, and is entitled to careful consideration by Government and public, not only on account of the intrinsic merit of the scheme, but also due to the age, experience, and great reputation of the author, who is one of the makers of the model State of Mysore. We hope that the Industrial Planning Committee appointed by the Indian National Congress will carefully weigh the scheme, and give it the necessary push and drive.

The Actual Proposal Examined

According to pamphlet No. (1), mentioned above, a factory should be started in Bombay, with a starting capital of 90 lakhs of rupees, and a working capital of 60 lakhs. The plant is intended to have a maximum capacity of producing 9000 cars, and 6000 trucks annually. The average annual outturn is expected to be 12000. In the early stages, it is proposed to manufacture such types of cars and trucks which are popular in India. If the capital be available, it is expected that not more than two years will be necessary to install the plant.

The motor car consists of 2000 parts, but even the biggest factories do not manufacture all the parts. There are feeder firms which specialize in the manufacture of only special parts, and all the manufacturing firms buy from them. It is expected that at the outset 300 parts will have to be obtained from outside. Many parts may be manufactured by firms well-established in Bombay. The raw materials to be used will be mostly available in India.

Technical Help

At present, it will be necessary to import foreign experts to take up the responsibility of designing, constructing and equipping the factory. Sir M. Visvesvaraya thinks that the necessary experts can be obtained by arrangement with a foreign firm of manufacturers, say the Ford Car Co., which gave such help to Russia about five years ago. The method suggested is very much the same as followed successfully in Russia which six years ago imported all its cars, but is now manufacturing about 200,000 vehicles per year.

Finance

The capital is to be raised by issue of shares and the provincial governments are expected to contribute substantially. The administration is to be vested in a Board of 20 Directors, of which 11 will be nominated by the provinces, and 9 to be nominated by the ordinary shareholders.

Protection

The success of the factory will depend on the protection given in the early stages. The Government of India should be persuaded to give a sliding scale of protection, as in the case of the sugar industry, so that it will be impossible for foreign firms to kill the Indian factory by underselling or by any other unfair means. Such protection, to the extent of 100 per cent of manufacturing costs, is given in every country of the world.

Modern Practice in High Voltage Measurements

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Introduction

THE present civilization owes its existence mainly to the utilization of mechanical power by man. The steam engine altered the human outlook and paved the way for large-scale industrial development. During the nineties of the last century it came to be realized that the main source of power for economical use at home and in industries would be electrical energy. The problem of transmission of electrical power from its source of production to the different consuming centres has since engaged the attention of engineers. In early stage, aerial lines supported on insulators were used for transmission purposes. The general laws of propagation over lines, though theoretically understood, could not be clearly worked out to meet the exigencies of the time. The method of transmission has, therefore, suffered many changes with the passage of time and accumulation of scientific data.

Unlike America and the continent of Europe, transmission by means of overhead lines did not find general favour in England at the outset, due to the fact that the power production and consuming centres were in the close proximity of crowded cities. In these cases power transmission could only be practical when it could be underground. The first underground cable, paper-covered lead-sheathed cable, had its inception at the power station of Deptford in 1896 due to the ingenuity of Ferranti. This was the precursor of the modern underground high voltage cable for power transmission purposes.

The rate at which the transmission voltage has increased is really amazing. The following figures will show how from 1890 the gradual development of the technique enabled the engineers to increase the transmission distance by adopting higher and higher voltage at the production centres. Thus one finds,

Year.	Operating voltage.
1890	2 kV
1892	6.6 „
1894	11 „
1897	22 „
1901	33 „
1907	110 „
1909	132 „
1912	154 „
1920	220 „
1928	280 „

The high voltage generation and transmission has been found to be economical in more aspects than one. The relation between the increase in the output of the plant and the economical working factor has been significantly pointed out in the report of the electrical power development of U.S.S.R. where it has been shown that in 1913 the average efficiency of the biggest electrical station in Russia was 10.7% for a 5,000 kW. plant consuming 2.5 lbs. of standard fuel per kilowatt hour generated whereas in 1935 the plant capacity has increased to 50,000 kW. ensuring an efficiency of 27% with a fuel consumption of 1.2 lbs of coal per kilowatt hour. The generating voltage also has increased from 6,500 volts to 33,000 volts, and at present this has become the limiting voltage for direct generation from alternators in the case of big stations all over the world. In the case of the newly constructed Battersea Station, the voltage of generation is also 33,000 volts using 0.94 lbs of British coal per kWH., having an average efficiency of 27.7%.

MODERN PRACTICE IN HIGH VOLTAGE MEASUREMENTS

Although the original purpose of developing high voltages was the economical transmission of power over long distances, in more recent times it was soon found that there were other problems regarding the transmission voltages. At present in a number of cases pressure has been determined not by the distance of transmission, but by the magnitude of power that had to be transmitted even over comparatively short distances. The advancement in the idea of power transmission led to more and more rigorous theoretical investigation for the proper understanding of the H.V. phenomena, and their practical utilization. It has been a comparatively easy matter to increase the voltage of alternating current transmission to the present high value, and even now it is not the question of transformer design that sets a limit to the maximum voltage of transmission but problems connected with the transmission line itself. The different properties of material required in the manufacture of high voltage cable together with the different types of insulators used to support the aerial lines had been of paramount importance to maintain the security of service as well as safety of operators in their manifold duties concerning the proper supply of electrical energy.

If one looks at the progress of high voltage power lines in the United States of America, one finds voltages as high as 350 kV., covering large areas of the huge continent. From the official statistics published in 1936, (*Electrical World Supplement*, May 9, 1936), it appears that there are at present in the States 140 systems having 1784 generating stations with a total output of 103 thousand million kW. It may not be a matter of common knowledge that though the United States was the pioneer of hydroelectric development, the total rating of steam plants (21,653,592 kW.) is nearly three times that of its hydroelectric stations (8,841,401 kW.). Even in the Niagara region steam plants compete successfully with the famous hydroelectric plant, Niagara Hudson Power Company; 8 fuel burning plants of total capacity of 640,650 kW. are working against 100 hydroelectric plants of total rating of 1,038, 562 kW. There has also been considerable increase of power consumption in Germany, France, Italy and in other countries.

The English Grid System

In England within the last ten years, after the introduction of the grid system, there has been considerable increase in the consumption of electrical energy. A record total of 24,315 million units of electricity was generated in 1937 (*Engineering*, June 10,1938, pp. 656) by authorized undertakings in Great Britain as against 11,000 million units in 1926. This progressive development of electrical power supply in Great Britain was due to proper planning and organization. In 1924-25 the Weir Committee was appointed to investigate the state of electrical industry in Great Britain. On the basis of the recommendations of this Committee the Electricity Supply Act of 1926 was enacted. This act provided for the creation of a national organization—the Central Electricity Board—to concentrate the generation of energy in a limited number of selected generating stations and to interconnect these stations linking up the existing regional systems into a national "Grid" by the erection of high tension main transmission system. It has brought into existence a new type of public board, a Central Electricity Board, for solving the problem of making the most effective use of national power resources within the existing administrative and economic framework. In July 1935, another committee was formed under the Chairmanship of Lord McGowan "to bring under review the organization of the distribution of electricity in Great Britain, including the control of statutory electricity companies by other companies, to advise on methods by which improvements can be effected with a view to ensuring and expediting the standardization of systems, pressures and methods of charges, further extending facilities (including supplies in rural areas) and reducing costs and to make recommendations." It will be seen from this report that the average revenue received per unit of electricity sold, in the case of supplies for lighting, heating, cooking and shops and office purposes in 1921-22 before the introduction of the Grid was 5.75 d. whereas the same average value was found to be 2.28 d. in 1933-34. The charges for power supplies decreased from 1.69 d. in 1921-22 to 0.73 d. in 1933-34. At present, over 60 per cent of the domestic consumers are paying 0.5 d. per kWH. and 2½%, need not pay more than 1 d. (The Report of the British Electrical Development Association—*Engineering*, March, 25, 1938, pp. 334).

MODERN PRACTICE IN HIGH VOLTAGE MEASUREMENTS

The above facts and figure tell their own tale and indicate how high voltage generation and transmission under proper planning and organization lead to economic stability regarding national developments. Russia in 1919 launched upon a vast plan of electrification of its huge area, and remarkable developments in power production is noticeable due to H.V. generation and transmission within recent years. Japan within the last 10 years has made astounding advancement in high voltage production and power generation.

Cost of Installation of Electrical Plants

Mr. D. H. Perry in a recent article (*Elec. Review*, Aug. 5, 1938 pp. 179) on "Power Stations of the Future" has discussed the comparative capital costs of different types of generating systems. His findings are that for sets of 40,000 kW. the cost is £11.6 per kW., for a low pressure plant. For a high pressure 70,000 kW. plant the fixed cost of average power stations including capital, charges on plants, auxilliary works, buildings, site and fixed charges on salaries, wages, repairs and maintenance is £3 per kW. If the power station is increased to 200,000 kW. capacity with a high efficiency boiler plant the cost works out at £2.2 per kW. These figures are indicative of the fact that large-scale power production and especially high voltage generation is not only economical for working purposes but also for the capital outlay on plants.

Coming to our own country, we find that power generation schemes in India are marching at a much slower rate than any other country, though it is being given out that tremendous efforts are being made to utilize the resources of its water power and of fuel, for the production of high voltage electricity. The Indian reserve of coal has been roughly estimated at 80,000 million tons and taking about 3 tons of coal for 1 kW. year, it is possible to have an average annual output of more than 27 million kW. with a life of 1000 years. And the minimum water power from the latest survey would yield approximately 7 million kW. year as electrical energy,* of which hardly 5% has been developed or is in the course of development. Taking the Indian Power production from Electricity Supply undertakings (as shown in the *Statistical Year Book of the World Power Conference, 1934*), to be 1,130† million kWH. and the population (as shown in the last census report of 1931 Vol. I part 1 page 4) as 353 million, one finds that the average annual consumption of electricity per head of population is about 3.2 kWH., whereas with a population of 40 million for England and Wales it is nearly 600 kWH. *per capita* per year. It is needless to say that the index of civilization and economic activity as judged from these figures is lamentably low for India. Taking a very moderate estimate of 100 kWH. per head per year for India, for near future, in order to raise her standard of civilization it would mean that India has to consume roughly 34,000 million units in a year. This would mean a large-scale industrialization of the country which is only possible if the electrical power resources of the country are developed to the maximum extent and supply at the cheapest rate possible placed at the disposal of the consumer. One of the reasons standing in the way of the large-scale industrialization of the country is the lack of proper planning regarding the establishment of large output and high voltage power plants. Here the practice has been to install isolated low output and low voltage plants in the majority of cases and even where high voltage plants have been erected the cost indicates that there is something abnormal so far as capital charges are concerned. That is to say the power supply in India is years behind the times inspite of all modern advances in the methods of production and transmission.

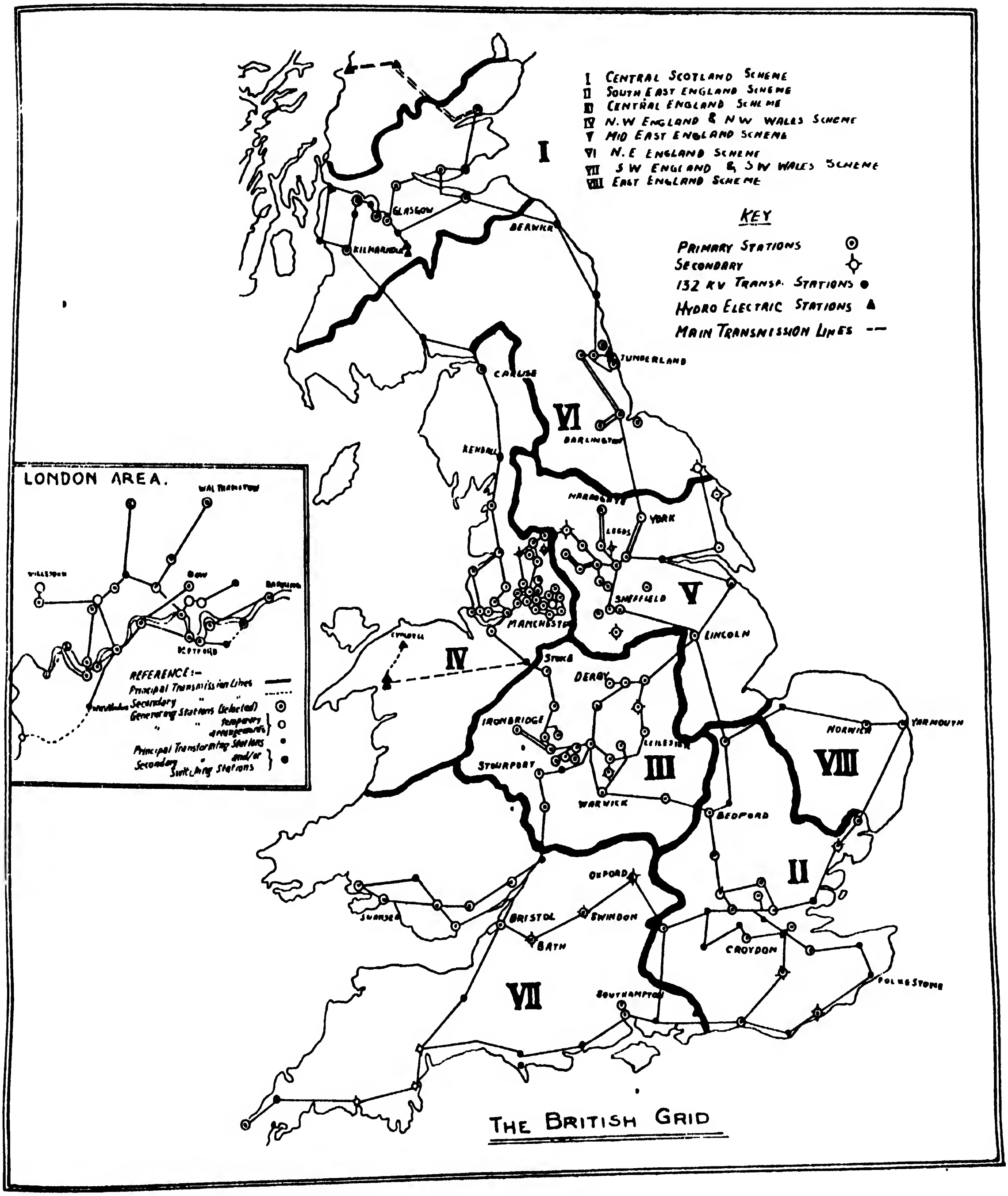
Electrical Plants in India

The electrical development in India can be roughly divided into four well-marked regions, *viz.*, Bombay, Madras, Bengal, and the Northern India side. The Bombay side comes within the enterprise of the Tata group and though of late origin, they have made considerable development in power production. Starting in 1916, they arranged for

*There has never been a proper survey of India's hydro-electric power resources. The figures quoted are merely guess-work and may be subject to a gross error. —*Ed. Sc. & Cul.*

†This figure appears to be an underestimate. The present figures would amount to about 2000 millions units.

The British Grid



In England during the last half a century there had been considerable growth of isolated electric generating stations all over the country. Soon after the termination of the last World War it was realized that a national planning regarding power production was desirable. To enable the most efficient plants to operate at their best, it was

necessary to link up the generating stations throughout the country by means of a transmission net work. This is the so-called "Grid System".

Historical

In 1926, an Act was passed creating a Central Electricity Board with the primary intention of concentrating generation for public supply purposes at a limited number of selected stations and interconnecting these with each other and with the distribution systems of authorized undertakers with a view to supply the energy for the national requirements from the common pool thus formed. The generating stations are under the control of the Board and are operated by their owners to the Board's directions.

General Scheme

The scheme covers the entire area of England, Scotland and Wales, divided into the following primary regional schemes:

Central Scotland	Central England
N. W. England and Wales	S. E. England.
N. E. England	S. E. England (London area)
Mid. East England	W. England and S. Wales.

Supply Pressure

The most economical transmission pressure was considered to be 132,000 volts A.C., 3-phase, 50 cycles opearting on a overhead net work except for London area where the voltage selected was 66,000 volts A.C. operating on a underground single core system. The routes of these lines are shown in the sketch map on the reverse page.

Conductors

These are, for overhead work, steel cored aluminium. The central core being seven strands 0.11" diameter galvanised steel wire surrounded by 30 strands 0.11" diameter aluminium wire. The capacity of a single circuit is 50,000 kVA. with a corresponding current of 219 amperes at 132,000 volts A.C.

Towers

These are of lattice galvanised steel type with concrete foundations, the average height being 70 ft., normal span 900 ft. with conductors with spacing of 12 feet in vertical direction and 20 feet in horizontal direction. The towers are joined by an earth wire, consisting of 7 steel and 12 aluminium wires of 0.11" diameter.

Transformers

These vary from 7,500 to 75,000 kVA. connected Y on the H.T. side and $\wedge$ on the L.T. side. Small transformers operate with natural air cooling and a forced air blast is provided with the larger ones, voltage control is also provided.

Selection of Stations

The substations are of the outdoor type of standardized designs to suit various conditions.

Switch-gear

The switch gear design is standard throughout the grid. The rupturing capacity of the circuit breakers is 1.5 million kVA. The isolating switches are mechanically interlocked. The by-pass connection is normally opened but is used if a circuit breaker or transformer requires over-hauling.

Miscellaneous Apparatus

A 110 Volt, 240 A.H battery is provided in each substation for operating and indication purposes and a motor generator set for recharging.

Operation

A control room is provided in each area in charge of one man, who is in communication with the central office, and to whom instruments give information of all running plants, loads etc.

Summarised Advantages of the Grid

1. Obviates use of uneconomical and inefficient plant.

2. Cost of generation is reduced, since the amount of reserved plant is reduced.

3. Generating stations and units will be able to work at full load.

4. New generating plant will be profit earning from the start.

5. The load factor will be improved.

6. The supply will be easily given to less populated areas.

Transmission Tree

Primary Generating Station

requires (*i*) coal, (*ii*) water, (*iii*) transport, and (*iv*) land.

High voltage A.C. transmitted at 132 000 V.

Received at transformer substations.

Received by Secondary stations and transformed to voltage of local system (*e.g.* 6600 volts).

Transmitted to substations.

Distributed at 400/230 volts, A.C. 50∼3-phase.

Distributed as D.C. through converters for Traction, etc.

the transmission of power through a distance of 56 miles at 110 kV. The Cauvery power scheme of the Mysore State is a pioneer hydroelectric scheme in Southern India and started operation as early as 1902. It utilizes the gross head of about 410 feet of the Cauvery river falls near Sivasamudram where the power station is situated. The present capacity of the station is 42,000 kW. and is generated at 2,200 volts 25 cycle, 3-phase, and stepped up to 78,000 V. for transmission to Bangalore, Mysore, Kolar Gold Fields and other places of which the Kolar Gold Field forms the major load. Madras has been slow in developing its hydroelectric resources, but about eight years ago the Government of the Province decided to embark on an electrification programme for the Province, and also to develop, as the Government-owned utilities, some of their water-power resources. As a result of this the construction of the main Pykara Station, which utilizes the high head available from the upper reaches of the Pykara river in the Nilgiris District, began in January 1930. The estimated potential capacity of the full development is about 40,000 kW. The works were completed and operation commenced at the end of 1932. The transmission system, as at present constructed with Pykara as the source of supply, consists of the double circuit 110 kV. line to the receiving station at Coimbatore, the load centre of the system with 66, 22, and 11 kilovolt lines radiating from it. This plant works under the highest head in the British Empire and the continents of North and South America. The 110 kilovolt line from Pykara to Coimbatore, at present, is being operated at 66 kV and it is proposed to raise this voltage to 110 kV after the Pykara Scheme Extensions are completed by the end of 1938 as is expected. The Mutter Hydroelectric Scheme which commenced operation in June 1937 transmits power at 66/110 kV to Erode in the South and to Singarappet in the north. From Singarappet, it is proposed to extend the transmission system to Madras eventually. The Northern India Hydroelectric Scheme in Mandi State utilizes the snow-fed water of the Uhl river and is designed for an ultimate capacity of 120,000 kW. of which the first stage of 48,000 kW. has been in commercial operation since April 1933. The generating voltage is 11,000 and the main transmission lines at 132 kV. radiate from the Power House at Jogindra Nagar to Amritasar, Lahore and Jullunder. From Lahore to Ferozpore and Lyallpore 66,000 volt lines radiate to supply these and certain other intermediate towns while the 33,000 volts line extends from Jullunder to Ludhiana. In the United Provinces, the Ganges Canal Hydro-Electric Scheme is essentially a low head scheme exploiting the water power sources of a number of low head points at different places on the 200 miles of the canal between Hardwar and Sumera. The present total capacity of the Ganges Canal Hydroelectric Scheme is approximately 16,000 kW. The four power houses at Bahadurabad, Bhola, Palra, Sumera, totally 7,500 kW., cover a range 600 miles with 37 kV lines and 450 miles with 11 kV lines. There are other hydroelectric stations of minor importance, *viz.*, of Jhelum, Jammu, Gokak, Darjeeling, Simla, Mussouri and Malakand. At every place high voltage transmission varying from 15 kV. to 66 kV. is in use. In Bengal, India possesses the largest thermal station; namely, the Calcutta Electric Supply Corporation Ltd. Starting in 1897 with a capacity of only 1000 kW. it has gradually expanded to 184,000 kW. at the end of 1933. And the new scheme that is under construction, will increase the capacity to 45.000 kW. and high voltage transmission at 132 kV. is under contemplation.

From the foregoing survey of the electrical power generation and power transmission one can easily notice that within the last quarter of a century there has been a phenomenal growth in the generation and distribution of electrical energy all over the world and one cannot fail to observe that the possibility of this could be attributed to the knowledge accumulated within this period regarding higher and higher voltages. High voltage technique thus forms an essential element in the maintenance of power for every nation and the various countries of the world have devoted themselves to the investigations of high voltage phenomena in its various aspects for their nation building work. The pioneer investigation evidently was that of the United States of America, but other countries of the world have not lagged far behind. In Germany the subject attracted attention as early as the beginning of this century. In France, there has been quite a rapid progress and Italy has taken up the

investigations of late. Japan has established its H.V. laboratory quite recently. Though rather late in the field, the contribution of England is not inconsiderable. There have been no serious attempts in our country to understand the basic importance of such investigations, though expansion of electrical power distribution is progressing at a fairly rapid rate.

At the outset one can readily notice that the whole success of the H.V. apparatus depends upon the knowledge of the insulating properties of materials. The different ceramic materials, such as porcelain, glass, steatite, and magnesia products; minerals, such as mica, petroleum, oils, vegetable products like cotton, paper, silk, rubber, resins are essentially the materials which are used now, as in the early days of electrical engineering. But though the materials are the same, more and more refined technique has been developed to utilize them in H.V. equipment. Here theory and practice went hand in hand. Progress of this nature could only be made by continual testing and research, it being the business of the high-voltage engineers to study the special problem of design and manufacture of apparatus to withstand high voltage whether these are meant for normal service voltage or abnormal conditions arising out of a number of extraneous causes.

It may not be out of place to state in this connection that in the realm of atomic physics higher and higher voltages are now being employed for research purposes which may ultimately affect public welfare. X-ray therapy is being extensively applied to the treatment of various diseases including cancer and the research on the effects of higher voltage X ray on the human system is being actively pursued in various institutions.

It will be worth while now to discuss the various aspects of the high voltage technique that has been developed and the methods that have been adopted to investigate the various phenomena connected with H.V. generation and transmission. Four kinds of high voltages are used to ascertain the reliability of insulating materials and apparatus under working conditions. These are low-frequency alternating voltages, uni-directional impulse voltages, high frequency alternating voltages and constant voltages. At the present time in America the highest A.C. low-frequency voltage equipment is one of 2250 kV. at Mansfield, the highest impulse voltage is 5 million volts at Pitsfield and the highest D.C. voltage is 3 million at Round Hill.

(To be continued)

The Problem of Soil Erosion in India

The aggregate losses to national wealth caused by soil erosion and its accompanying phenomena are enormous and steps must therefore be taken to reduce them as far as possible.

In a lecture at the Royal Society of Arts on "The Problem of Soil Erosion in the British Empire with special reference to India," (*J. Roy. Soc. Arts.* 86, 1938) R. Maclagan Gorrie of the Indian Forest Service has dealt with the problem of erosion in all its important aspects particularly with reference to the erosion problems in the Punjab. In his lecture the speaker has mentioned Lowdermilk's experiments at Berkeley, California, which show that the value of a forest litter lies not so much in its capacity to absorb water as in maintaining the soil surface below the litter at its maximum rate of intake. In such cases the surface water is transmitted to the lower underground layers, and thus the amount of erosion is considerably less than with bare soil.

A technique of volumetric analysis of water and silt has been recently worked out by the Punjab Irrigation Research Institute staff at Madhopur for a type of small isolated plots of undisturbed soil, 3½ sq. ft. in area. The figures show that in a single storm (5¼ in.) the uncovered plots lost 1½ tons of soil per acre. The enormous loss by erosion will also be exemplified by the fact that at the Bombay Dry Farming Research Station at Sholapur a loss of 115 tons of soil occurred per acre per annum from a field of *jowar*, a *sorghum* which is the most important combined grain and fodder crop in the Bombay Deccan. The experiments on erosion in the Punjab and at Sholapur have also brought out that good cultivation on a slight slope is no better than bad cultivation for saving soil unless it is protected by some form of contour ridging.

Dr Gorrie recognizes that the serious nature of soil erosion can only be controlled by a broad programme which includes plant and animal conservation, the reasoned use of land which Nature intended as catchment areas, the building of drains and reservoirs along river courses and a more intelligent agriculture. It is however very difficult, as the speaker has been careful to point out, to put such programme into practice among intensely conservative and often primitive and spendthrift people. Hence the education of the masses must first be undertaken and force of public opinion created before any effective action can be undertaken.

Dr Gorrie points out that for effective control measures, co-operation and team-work amongst the revenue staff, the agricultural staff, the veterinary staff and the forest staff is necessary. The recently developed branch of Rural Reconstruction in the Punjab has already made considerable progress in this direction by popularizing the various phases of erosion control.

In the United Provinces alone there are some 15,000 sq. miles of uncultivated waste land, much of which, with proper management, could produce more fodder and fuel than it does now. In this province a five-year plan to provide better fodder and grazing for 40 million domestic animals has been drawn up, and a special officer has been appointed for this work. The plan is to examine research projects and initiate fodder and grazing experiments and develop fodder production from the eroding ravine lands of the Gangetic plain. In treeless areas the main fuel is the cowdung cake and the chief justification for village afforestation projects is to stop this extremely wasteful habit by providing a cheap supply of fire wood.

In certain types of deeply curved topography the steep banks of many streams are in a crucial state, and special precautions ought to be taken to protect them. One type of riverside conservation would be to confine the stream to a more clearly marked bed by means of low bunds built parallel

to the stream and the afforestation of the reclaimed land with any tree and bush species which will flourish in the sand.

So far as the conservation of grass land for livestock is concerned the prevention of erosion and the conservation of a meagre and irregular rainfall would rejuvenate the grasslands to an amazing extent. Increased seepage is necessary and this can best be done with some form of contour trenching.

In a discussion on Dr Gorrie's paper Sir Albert Howard in " A note on the problem of soil erosion " (*J. Roy. Soc. Arts. 86*, 1938,) points out that although the damage done by uncontrolled erosion all over the world is very great, a considerable amount of new soil is being constantly produced by natural weathering agencies from the subsoil and the parent rock. This, when suitably conserved, will soon recreate vast stretches of valuable land. Sir Albert feels that soil erosion is mainly due to defective methods of agriculture, *viz.*, over-stocking, over-cropping, over-stimulation of the soil, the wholesale destruction of forests and other malpractices which destroy soil fertility.

Generally in India, as elsewhere, the more obviously valuable forest areas have been reserved. Unfortunately they often form a small proportion of the total land surface. The creation and maintenance of suitable forest cover should be more actively encouraged, than has hitherto been done, by the Government of India. Vast tracts of hilly lands are lying waste and are being gradually degenerated so far as their productivity is concerned. Agriculture by terracing and bundling of these hilly areas is needed. Indeed, the first immediate step which should be taken is to recognize the essential nature of soil erosion and soil degeneration in each individual instance and to take effective steps to conserve the fertility of the soil.

Dealing with erosion Sir John Russell, in his recent report to the Imperial Council of Agricultural Research, stressed the view that the need was for more action rather than for more research. He feels that protection against erosion should be a State responsibility. Sir John has recommended the annual holding of an Erosion Conference in all provinces where erosion is likely to occur, at which forestry, animal husbandry and soil experts should meet the agricultural staff and discuss about the mode of checking or remedying soil erosion, dealing with each erosion area as a whole. The report of Sir John is still under the consideration of the Government of India whose final decision on this very important problem will be awaited with keen interest. The suggestion of Prof. M. N. Saha on the establishment of more River Physics Laboratories and the recommendation of Sir John Russell for the creation of a separate Research Institute, where the problems of irrigation in India could be tackled, should also be considered, in this connection. The problems of erosion and irrigation are interconnected and both the problems should be handled simultaneously.

S. P. R. C.

Experimental Evidence about the Existence of the Neutrino

As is well known, there has been considerable difficulty in providing a satisfactory explanation of the continuous distribution of energy amongst the individual β-particles emitted by a radioactive element,* and this difficulty in explaining the energy distribution led Bohr to suggest the renunciation of the law of conservation of energy and momentum for β-disintegration processes. The law of conservation of angular momentum also seems to break down in the case of β-decay. The non-conservation hypothesis of Bohr encounters serious difficulties, both from experimental and theoretical sides. Pauli pointed out that the principle of conservation of energy and angular momentum will remain valid if it be supposed that during β-disintegration, a new particle which is escaping observation is emitted along with the β particle carrying away part of the energy and angular momentum. This particle which he termed *Neutrino* should possess no charge, a mass negligible or very small in comparison with that of the proton, and spin $\frac{1}{2}$ h or any odd multiple of that. The probability of the existence of such a particle has been further strengthened by Fermi's theory of β-ray disintegration which is based on the postulate of existence of neutrinos.

On account of the absence of charge and very small mass, it would be extremely difficult to detect the neutrino by direct experimental observation. Due to absence of charge it would not produce sufficient ionization to be detected in the Wilson chamber or in any other ionization experiment; due to its small mass, it will be hardly possible to observe any nucleus set in motion by collision with this particle as can be easily done in the case of the neutron. If electrons could be set in motion by collision with this particle they could be experimentally detected, but the probability of such collisions, as has been shown by Bohr, is extremely rare. Attempts by Chadwick and Nahamias for their detection yielded negative results. Quite recently, however, some experimental evidence has accumulated which definitely indicates that during the process of β-ray disintegration, a portion of the energy and momentum is taken up by an uncharged particle like the neutrino.

The most direct method of investigation is that used by Crane and is based on the following consideration. During a spontaneous nuclear disintegration, it follows from the law of conservation of momentum that the algebraic sum of the momenta of all the particles taking part in it is zero. If by any method, the momenta of the β-particles and that of the recoil atom be measured then, whatever the velocity with which the β particle is emitted, the momentum of the recoil atom should always be equal to that of the β-particle, provided no third particle is emitted. If the shape of the observed momenta distribution curve for the recoil atom does not agree with that for the β-particle, then either the law of conservation of momentum does not hold good or a third particle takes part in the disintegration process. Another possible explanation that the mass of the electrons is variable (Jauncey's hypothesis that at the time of emission, the β-particle is a heavy electron) is found to be untenable. This point will be referred to in a later note.

Crane and Halpern (*Phys. Rev. 53*, 789, 1938) have actually estimated the kinetic energy of the recoiling atoms during a β-disintegration process taking place inside a Wilson chamber, by measuring the total amount of ionization produced by those recoil atoms. The lighter the mass of the recoil

*See article in SCIENCE AND CULTURE by R. N. Rai (*I*, 458, 1935-36).

atom, the greater will be its energy of recoil for a given energy of the emitted β-ray and in his automatic Wilson chamber experiment he used a trace of radio chlorine Cl^{38} in the form of ethylene dichloride vapour. Cl^{38} emits electrons with an upper energy limit 5 MeV and has a half life of 37 minutes, which allowed sufficient number of photographs to be taken, showing the track of the β-ray and the recoiling nucleus. As the ionization produced by the recoiling nucleus is a function of the kinetic energy of the same, by counting the number of droplets condensed along the track of the recoil atom, its kinetic energy could be estimated. The momentum of the ejected electron could be determined by magnetic deflection of its track.

Crane plotted curves with the momenta of the emitted electrons as the abscissa and the number of droplets per recoil atom to be expected on three assumptions, *viz*:

(1) The momentum of the nucleus is equal to that of the electron (which is equivalent to assuming that there is no neutrino).

(2) A neutrino of very small rest mass escapes in the same direction as the electron. The momentum of the neutrino is taken to be $(W-E)/C$ where W is the upper limit of energy in the β-ray spectrum of Cl^{38} and E the energy of the electron calculated from curvature in the magnetic field.

(3) The same, but electron and neutrino escape in opposite directions.

The data obtained showed that when β-rays of small momentum are ejected from radio-chlorine the number of droplets observed is greater than demanded by the first curve on assumption (1), so that the momentum of the recoil nucleus is greater than what it could have received from the β-ray alone, thus pointing to the existence of a third particle taking part in the disintegration. If all possible directions of emisson of the neutrino with respect to that of the electron be probable the number of droplets produced corresponding to the emission of β-particles of varying momentum should lie between the two curves drawn on assumptions (2) and (3) representing upper and lower limits and this was actually verified by the results obtained.

There is one inherent weakness in Crane's method as it is based on the assumption that ionization produced by the recoiling atom is a function of its kinetic energy and in his calculation it has been assumed that one ion pair is produced for each 30 eV of kinetic energy. Wertenstein (*Phys. Rev. 54*, 306, 1938) has pointed out that the relation between kinetic energy and ionization produced is rather complicated, energy expenditure per ion pair increasing rapidly when energy of ionizing atom tends towards zero. Crane (*Phys. Rev. 54*, 306, 1938) while admitting the weakness of his assumption still claims validity of his conclusions. Crane finds that on repeating the same experiment with P^{32}, N^{14} or Cl^{38} for emission of β-rays of same energy (1-1.5 MeV), P^{32} or N^{13} disintegration produces no visible cluster of droplets while corresponding Cl^{38} disintegration produces quite a large number of droplets. The energy of recoil given to the atom by the β-ray alone in these cases (P^{32}, N^{13}) is of the order of 25 eV which is too small to produce any ionization. The ionization produced in the case of Cl^{38} disintegration is therefore evidence of a much greater energy of recoil which is to be attributed to escape of a neutrino of considerable energy. Crane has also pointed out that even where ionization does not take place by slow-moving atoms, formation of droplets may take place owing to dissociation of N_2 and O_2 in the Wilson chamber and consequent formation of NO_2, N_2O etc., which provide excellent centres of condensation. Droplets formed in his experiments might be partly due to dissociation rather than wholly due to ionization produced by the recoil atoms. Interpretation of droplet counts in that case however has to be made on the basis of direct experiments.

Leipunski (*Proc. Camb. Phil. Soc. 32*, 301, 1936) has also measured the energy distribution of light recoil atoms during β ray disintegration of active carbon C^{11}, which emits positrons. The recoiling nuclei possessing different energy were sorted out by applying a retarding potential so that only those possessing certain energy could pass through, when

they were accelerated to 5,000 volts and allowed to strike a metallic surface which emitted electrons These electrons were accelerated and attracted into a Geiger counter. From the number of counts with varying retarding potentials data were available for constructing energy-distribution curve for the recoil atoms. Leipunski's data also shows that some of the recoil atoms at least possess energy greater than could be obtained from the recoil of the β particles. This gain in energy of the recoiling nucleus may be directly attributed to the additional recoil gained from neutrinos, which escape with the β-particles.

Recent theoretical investigations by Hoyle (*Proc. Camb. Phil. Soc.* *38*, 277, 1937) and others on the energy distribution curve for electrons emitted during a β-ray disintegration process seem to indicate a possibility of determining the mass of the neutrino. Konopinski and Uhlenbeck have shown that the empirical β-ray spectra seem to require a modification of Fermi's original expression for the interaction leading to β-ray decay. Their interaction expression includes a derivative of the neutrino wave function. According to the transformation of the theoretical formulae of Fermi and Konopinski and Uhlenbeck, intrduced by Curie, Richardson and Paxton (*Phys. Rev.* *49*, 561, 1936) for the purpose of comparison with experimental data, the experimental points should lie on one straight line if Fermi's formula is correct and in another straight line if K-U formula is correct. Fermi's formula, it is found, cannot correctly reproduce the experimental results, while K-U formula is in good agreement with the experimental observation between the range 100 kV and not too high a value of the electron energy. At the highest energies in the neighbourhood of the upper limit the experimental points deviate appreciably from the theoretical curve by an amount which is outside the limit of experimental error. Hoyle has tried to explain this difference by introducing a finite mass for the neutrino, and from this deviation he has estimated the mass of the neutrino. From Lyman's data for the β-ray spectra of P^{32}, the value of neutrino mass μ comes out to be equal to 0·47 m_o, where m_o is the rest mass of the electron. From his accurate measurements on the β ray spectra of RaE, Flammersfeld (*Z. F. Tech. Physik* 547, 1937) finds μ 0.5 m_o, but his experimental points do not fit in very well with Hoyle's curve.

The 'Neutrino' therefore remains quite elusive.

S. D.

Interests and Abilities as Indicative of Vocational Pursuits

K. C. Mukherji

The psychology of interest is as yet obscure and complex. It has not yet reached that stage when definite formulations could be made with regard to its application or use. The reason is not far to seek. Interests are very intimately related to knowledge or information. One can hardly be interested in that of which one has not sufficient knowledge, and we may as a rule say that the more one learns about things the more interesting they appear. Moreover it is true that we learn most about things in which we have the greatest interest and without some amount of interest, either intrinsic or derived, learning would have been almost impossible. There are other factors as well which contribute towards the complexity of the subject. One such important factor is the relation of interest with ability which is oftener than not misunderstood and misrepresented. Much of the misunderstanding can be removed if the distinction between the two is well appreciated. One of the points to be remembered in this connection is that they go hand in hand and are interdependent. Each is largely a product of the other. Most people are interested in doing things at which they are proficient, or in other words they are interested in a thing because of some underlying ability in connection with it. The results obtained by some recent experimenters, however, throw doubt on the above statements. In fact these experimenters contend that interest is of little value as a criterion of ability, though it is only slightly suggestive of such ability. Thus it is evident that interest may be allied with ability in particular cases but on the average we cannot wholly rely on this as the only criterion of predicting abilities.

There are exceptions and limitations to all these statements, and these add further to the obscurity of the topic. Apart from all these drawbacks there is the factor of change which sometimes alters the situation, and gives it a new appearance. Interests, both intrinsic and derived, change with the gradual change in the mental make up of the individual. Added knowledge and new growth give rise to new sources of interest. The psychology of interest is obscure furthermore because of the difficulty of identifying and measuring or comparing various interests. The measuring of interests is more difficult than identification, and unless this can be fairly assured the whole psychology of interest will recede to the background. A child may evince interest in various things and unless we can identify fairly accurately his intrinsic interests for particular things and can measure their relative strength we shall not be in a position to help him in his vocational guidance. Moreover, it is assumed that the child cannot equally prosper in all the subjects in which he evinces strong interest and as such there must be some arrangement for measuring the relative strength of his interests.

No doubt, there are difficulties in the field, but there have been attempts to measure and analyse interests, though none of them is wholly satisfactory. The procedures that have been so far followed for measuring interests may be conveniently divided into (*a*) the Direct and (*b*) the Indirect methods. The direct method consists of some questions to be answered by the subject. These questions ought to be systematic in character. It presents the subject with lists of heterogeneous collection of objects, activities, occupations, recreations, etc. He is required to mark them as interesting or uninteresting; or perhaps he may be asked to arrange them in order, according to their interest or he may be required to estimate by some grading or rating scheme their relative appeal to him. From the above description it is apparent that this method has a serious drawback, namely, that it presupposes ample opportunity on the part of the individual to acquire his interests, that is, he has a knowledge

of them, requiring only to formulate them clearly or express them explicitly, for otherwise they are fairly well settled. A little reflection will convince one that in practice this is not the case. The indirect method differs from the direct one with respect to the emphasis and importance that it lays on the knowledge of the examiner and the part that he is destined to play in it. Moreover, the two methods may be said to be widely divergent, for they start with quite different suppositions. While the former presumes knowledge on the part of the subject, the latter assumes that whatever the sub ject does or has done can be proved to be symptomatic of his interests which need not be always conscious *i.e.*, the subject may not be always aware of his interest corresponding to any parti cular act or behaviour. The only thing that remains to be done according to this method is the right interpretation of his acts by the examiner. Thus according to this method the individual is examined on an array of different test items for eliciting information, the assumption underlying being that information follows and betrays interest. Or the individual may be asked to narrate his past life, his activities in detail, his games, his favourite books, his favourite recreations, his pets, his toys, his social participations, etc., the assumption in these cases being that his acts and choices in the above cases have unwittingly grown out of his interests which are mainly intrinsic. This method admits of some alterations and modifications suited to the particular case but generally they will remain the same in principle. Many such tests have been devised and put to experimental use but none yielded satisfactory results, and since they are still tentative, none of them is here advocated for practical purpose. But these results have served the valuable purpose of promoting further research in this field. In America the questionnaire method is commonly used for the exploration of vocational interests. This procedure comes under the Direct method, which has been described above. Moreover, it is desirable that the subject's answers to the questions should be discussed in an interview to be arranged for this purpose, so that the reasons for his likes and dislikes may be investigated. During this interview it is also essential that the examiner should pay careful attention to the subject's changing attitudes as revealed by gesture, facial expression, tone of the voice, etc. But, inspite of the great care being taken, the vocational interests as revealed by tests may prove to be of only a little help to vocational psychology as it is found that interests do not contribute to a great extent towards success in any profession as are expected.

From the point of view of vocational prediction a study and analysis of abilities is more important than that of interests. Statistical studies undertaken by renowned psychologists bear out the truth of the above statement. Thorndike found that the resemblance between ability in the elementary school and ability in college (both measured subjectively) was expressed by the correlation co-efficient of ·65; whereas the same between interest in the last three years of elementary school and capacity in the college period was found to be about ·60. In this case, however, the difference happens to be less pronounced but another study of college students undertaken by Brides and Dollinger brings out this difference markedly. They found the correlation between subjective interest and subjective ability to be ·57 whereas interest and actual grades gave only a coefficient of ·25, *i.e.*, a very low correspondence. The general conclusion from these studies is that interests to a great extent reflect the hierarchy of abilities within an individual but cannot so accurately determine his capacities. For this obvious reason the psychology of ability has developed more than the psychology of interest. For the study and analysis of ability, what is required at the very outset is the finding out of different abilities and their classification. Many attempts have been made to classify abilities and one such classification of inherent abilities is given below:— (*a*) skill in the manipulation of words and abstract ideas; (*b*) mechanical or motor capacity; and (*c*) social intelligence. The above classification is a very broad one. The first group of abilities according to the above classification is clearly related to clerical occupations, and there is a profusion of tests of intelligence of this order. For the purpose of occupational findings definite commercial tests may be used and they require no commercial knowledge to be possessed by the pupil but simply aim at testing his capacity for rapidly acquiring such knowledge. In this connection it may be

mentioned that the *series* published by the National Institute of Industrial Psychology is typical. Another study was undertaken to find the relation between educational interests and educational abilities but the results are similar to the previous ones. In this case it offers 60 chances in 100 for the prediction of abilities by educational interest expressions.

An exhaustive and comprehensive study was made to find out the relation between interests and different types of work, and it will be interesting to know the results, which were tabulated both quantitatively and qualitatively. From the quantitative aspect the results appear to indicate that individuals can usually make generalized interest distinctions of the sort called for in classifications of types of work. From the qualitative point of view it was evident that there was a confusion on the part of the subject between his interest in the type of work and his ability in that type of work. It is very difficult to avoid this confusion to any appreciable extent. The judgment as delivered by the subject seemed in so far as it was related to his interests to be based upon the feeling accompaniment to the thoughts of this particular task. Of course the above finding is in agreement with our understanding of conscious processes at large. The quantitative results, as stated above, appear lacking in significance when subjected to a searching analysis, for it has often been found that subjects fail to make any generalized interest distinction between types of work. Another questionnaire study was also made to verify the above results but the findings are a bit conflicting. However, the following conclusions are favoured by the general trend of the results:—

(1) Individuals are sometimes unable to make any generalized vocational interest distinctions of significant value for vocational prognosis, but they may do so with suitable care and training. Neither education nor intelligence seems to be responsible for this. Interest, which in the present instance consists of a kind of feeling towards certain occupations, cannot be expressed towards anything so general as a type of work.

(2) Types of work based upon fields of occupational interests can well serve the purpose of vocational counsel but the information process must necessarily be from the general to the specific and this accounts for the discrepancy in the results referred to above.

In summing up the conclusions it may be seen that the bulk of the evidence is in favour of the fact that vocational interests may outrun vocational abilities and talents and this is specially pronounced in the case of persons of lower general ability. These interests may be very permanent from the subjective point of view but that does not guarantee against their frustration. But in spite of all these, one positive service that the study of interest has rendered towards vocational psychology is the detection of emotional attitudes through the study of vocational interests. This is conveniently done by making use of pictures showing men engaged in various trades and asking the subjects to explain their likes and dislikes. Another fact that has been revealed through the study of interests is that the actual interests of men are in certain kinds of work rather than definitely in particular jobs, and it now appears that it is perhaps only such general dispositions that the various forms of interest analyses can reveal in any formal or calculable way. But we are still in the dark as to the actual conditions and factors that are at work.

It should be noted here that some correlational studies of interests have been made with regard to their permanence at different times, but the results are not above suspicion, and are moreover divergent. However, the general trend of the results shows that interests are not very permanent. There are exceptions and limitations of the above statement which admits of further researches.

NOTES AND NEWS

Adult Education for Bombay

The Bombay Government has decided that a Provincial Board for Adult Education should be constituted with effect from 1st October 1938 with Mr S. R. Bhagvat L.C.E., General Secretary, Rural Reconstruction Association, Poona, as Chairman.

The functions of the Board will be as follows:—

(1) to submit for the approval of Government a three-year programme for the spread of adult education in this province, with estimates of the expenditure—both recurring and non-recurring—that will have to be incurred for implementing each item of the programme;

(2) to conduct propaganda for the removal of illiteracy and other forms of ignorance among adults of both sexes *in rural* as well as urban areas;

(3) to encourage and supervise the publication of suitable literature for adult education;

(4) to consider schemes referred to it by Government or submitted by private bodies for the spread of adult education;

(5) to advise Government as to the best manner of aiding the existing adult education classes and of organizing and extending the work of such classes on a voluntary basis;

(6) to advise Government as to the best methods of harnessing the enthusiasm and spirit for national service among the educated youth of the province for the drive against mass illiteracy;

(7) to suggest means for co-ordinating adult education among villagers with other forms of rural reconstruction,

(8) to advise Government on the question of implementing the various recommendations made by the Adult Education Committee; and

(9) to collect funds.

Government desires that all officers of the Educational, Revenue, Agricultural, Co-operative, Public Health, Veterinary, Industries and Public Works Departments and the Backward Class Officer should give such assistance to the Chairman and members of the Board as may be necessary for implementing the programme of work that may be approved by Government from time to time. District Local Boards, Municipalities, School Boards, Village Panchayats, Village Improvement Committees, Taluka Development Associations and Co-operative Banks and Societies have been requested to co-operate with the Board in matters coming within their jurisdiction.

Reported Mineral Deposits in Gujerat and Rajputana

The Geological Survey of India report the discovery of several occurrences of building materials of considerable interest and ore bodies of varying possibilities in Gujerat and Southern Rajputana where systematic investigations were carried out by the Survey. Occurrence in certain parts of these regions is mentioned of thick bands of crystalline limestone containing small patches of white and tinged marbles, slabby calcareous bands suitable for building purposes, and also sandy bands which can be used both for building purposes and for manufacturing grinding stones. A rich deposit of bauxite in association with the Ahmednagar sand stones

in the Kaira District and also of galena in Bhamria State is also reported. A specimen of the quartz galena lode, assayed in the Geological Survey of India Office, gave 18.16 oz of silver per ton.

Small deposits of iron ores have been found in Jambughoda State in the hematite-quartzite hills about 1½ miles southwest of Jambughoda. Specular iron ores occur sparsely in association with phyllite and quartzite around Jambughoda. Two new occurrences of manganese ores have been recorded in Jhabua State and the Panch Mahals district. In the Jhabua occurrence massive psilomelane forms bulk of the ore. Crystalline aggregates of braunite, hollandite with rhodonite and piedmontite also abound. The new deposit in the Panch Mahals lies about three miles north of the railway station Anas of the B.B.C.I. Ry. The ore consists of pyrolusite, psilomelane and wad.

Fossil plants of Lower Cretaceous age have been discovered in the Ahmednagar sandstones near Himmatnagar (Ahmednagar), while well formed lamellibranch and gastropod shells have been found in many places in the Bagh beds. No fossils have been found in the Nimar sandstones of the area. The Lameta beds are also practically barren of fossil evidences but for occasional indeterminate fragments of lamellibranch shells noticed in the siliceous limestones of Balasinor.

Several typical lamellibranch and gastropod forms identical with those found in south Indian Upper Cretaceous beds have been discovered in the course of investigation in the Bagh fauna of the area establishing Cenomanian to Upper Senonian age of these beds.

The Deccan Trap consists of dark grey basaltic lava flows. The rock is characterised by general homogeneity of composition and compactness of texture. No inter-trappean beds have been noticed in the area, and it has not been possible to break up the Deccan Trap into distinct individual flows, not to give any information as to its age, except that it is post-Cretaceous.

Announcement

The Council of the Indian Science News Association, which conducts this journal, decided at its meeting held at the University College of Science. Calcutta on the 21st August, 1938 that a Board of Editorial collaborators should be formed. At the request of the council the following gentlemen have kindly agreed to serve on the Board:—

Sir Shah Muhammad Sulaiman Kt. LL.D., Dr N. K. Bose Ph.D., Dr Baini Prasad D.Sc., F.N.I., Dr K. N. Bahl D.Sc., D. Phil. F.N.I., Dr T. Bhaskara Shastri M.A., F.R.A.S., F.N.I., Prof. P. K. Parija M.A., F.N.I., I.E.S., Prof. H. K. Mookherji D.Sc., Prof. S. P. Agharkar Ph.D., F.N.I., Dr B. S. Guha Ph.D., Mr D. N. Wadia M.A., F.G.S., F.N.I., Dewan Bahadur Dr B. Sundara Raj Ph.D., Prof. M. O. P. Iyenger Ph.D., F.N.I., Dr. S. Hedayetulla Ph.D., Rao Bahadur G. N. Rangaswami Ayyangar F.N.I., I.A.S., Mr L. Mason O.B.E. M.C. I.F.S., Dr W. S. Jenkins D.Sc., I.E.S., Brigadier C. S. Lewis (Surveyor General)., Rao Bahadur V. A. Tamhane M.A., Prof. G. S. Ghurye Ph.D., Rao Bahadur K. N. Dixit M.A. Dr S. K. Mitra Ph.D., I.A.S., Mr J. M. Bottomley M.A., I.E.S., and Mr. N. G. Majumdar.

Intimations from some more personalities are awaited and a fuller list will be published as it becomes ready.

Chemical Patents in India

India has yet to develop her industries on a systematic basis. Whatever industrialization has been in recent days it has not been put on a proper, scientific basis, with the results that even in the internal market India cannot always hold her own. The reading of the annual report of the Indian Patent Office for 1937, which mentions a phenomenal increase in inventions relating to chemical industries, points out that out of the applications for patents in these inventions a large number of them originated in Germany and the United States. This at once brings home to our mind a systematic neglect on the part of the industrialists to induce the scientific workers of this country to come to their aid. It is a travesty of truth to say that there is a dearth of native resources and talents. What is wanted is the realization on the part of Indian industrialists of the necessity of bringing science to their aid in the development of the industries, and the proper initiative on their part in these matters. A marked increase during the year under review has been reported in the number of inventions relating to dyeing

and bleaching of textiles. The interest covered a wide range, such as, processes of dyeing textile fabrics with diazotized bases and diazo salts in conjunction with naturally occurring colouring matters, the preparation of artificial wool from jute and the production of new wetting agents from Indian vegetable oils. Now, for example, the textile industry on whose chemical problems so many patents originating mainly in Germany have been issued, is no longer in the scantily-financed and ill-protected initial stages of growth. The Indian manufacturer might have been hitherto led to believe in the futility of spending money on evolving improved methods and processes, as the Indian buyer is not generally fastidious and also due to the protection by tariffs. But it is time that they realized the dependence of industries on scientific research, without the aid of which there can hardly be any progress and improvement. Time has surely come when the industrialists can with great benefit to themselves take advantage of the discoveries of science and the phenomenal progress in scientific thought evident abroad and in India too.

Why not a Planetarium for India?

The heavens have always presented some difficulties to the young student, who is just beginning his study of astronomy, and the various motions of the heavenly bodies the traces of whose path he has often to draw on the canvas of his mind, seem often confusing to him. Models are therefore made use of by the teacher, and the more perfect a model of the heavens is the easier the more interesting it is for the young learner to grasp his subject. Besides, astronomy, being the exactest and the commonest of all sciences, naturally, engages the attention of all—and the educated mind cannot rest contented till he can explain for himself, may be in a less vigorous way than the academic scientist, the motions of the stars and other heavenly phenomena that present themselves to his sight every day. To obviate the difficulties and make astronomically education easier and more interesting, the idea of the planetarium was thought of. It is, in short, a model of the universe, which by mechanical processes can be made to reproduce the various astronomical phenomena, and consists of a spheroidal projector which represents the earth in its motion and is "made to reveal its many dozens of tricks." By the rotation of the projector on its axis, one can see the changes in the heavens as taking place due to the earth's diurnal motion. Precessional and altitudinal motions can also be reproduced, as also the planetary motions, the annual motion of the sun, and the other astronomical phenomena such as the Milky Way, eclipses, the pictures of the different constellations.

America to-day possesses five such planetariums, one each at New York, Chicago, Philadelphia, Los Angelos, and Massachusetts (the Springfield Museum). The last one was opened to the public on November 2, last year. It is perhaps the smallest and the least expensive of all the five, but, as its authorities claim, "the same results can be achieved with the Springfield instrument as with the more elaborate installations in other cities." The projector which is American designed and American made has cost only 12,000 dollars.

We in India have unfortunately not a single planetarium to boast of. The function of a museum in the West is quite different from one in India which is but a store-house of curios- -generally ancient. Museum education is foreign to the Indian public. We, however, wonder if it is not possible to have at least one moderately equipped planetarium, erected through the munificience of either the public or the Government or of both.

Forty Years of the Theory of Evolution

The period between 1859, the year in which *The Origin of Species* by Darwin was published, and 1900, "the year in which the rediscovery of Mendel's work began to lead to that reorientation of the biological sciences which is still actively going forward" was a remarkable age and the most fruitful for scientific discoveries. What, therefore, are the peculiar characteristics of these years, both in relation to the time that preceded it and the time that followed it. What were the main ideas, as different from those that hold the field to day. These are the questions that Prof. R. C. Punnet has sought to consider in a learned article "Forty Years of Evolution Theory" in the *Discovery* of September 1938. We quote below the concluding paragraph of this article in which he has beautifully summed up the main ideas:—

NOTES AND NEWS

" . . . . In the first place we still hold by the theory of evolution, regarding the world of living things as a dynamic, and not a static concern. The idea is of course an old one, and Darwin's chief glory, as Butler said, is not that he discovered it but that he made men believe in it and what glory, he added, could be greater than this? Natural Selection also is still with us, but in a rather different sense. For Darwin and his followers, owing to their conception of the nature of variation, it was in large measure a *creative* force, accumulating small variations until they attained a magnitude that enabled them to play a part in specific change. Our insight into the nature of variation has changed all this. Natural Selection, said Bateson, is a true phenomenon, but its function is to select. It plays the part merely of a selective agent on heritable variations, which have already arisen through an independent process of mutation, conserving the beneficial and rejecting the inimical, while producing no effect upon those that are neither the one nor the other. Through such limitations of its scope we are released to-day from the necessity of finding a use in everything merely because it exists. On the other hand continuity in heritable variation has gone, and with it the idea of continuity between species. Species are once more sharply marked-off things with hard outlines, and we are faced once more with the problem of their origin as such. The idea of yesterday has become the illusion of to-day; to-day's idea may become the illusion of to-morrow. "For," says Meredith, "the mastery of an event lasteth among men the space of one cycle of years, and after that a fresh illusion springeth to befool mankind." Doubtless many masters of the event will follow after Darwin and Bateson in wielding the Sword of Aklis, and through the dispelling of illusion after illusion mankind may eventually encounter the ultimate residue, perhaps the ultimate of all illusions, which we optimistically designate as truth."

Problems of Adult Education in India

At a joint meeting of the National India Association and the East India Association, held on June 30, a paper was read by Mr Banning Richardson, General Secretary of the All India Adult Education Conference on the 'Social Implications of Adult Education in India.' The paper, coming as it does from such an authority on adult education as Mr Richardson, is remarkable for lucidity of exposition and clarity of thought. The diverse problems of adult education in this country have been admitted to be very complex, and they, according to many, defy any solution. There has been of late, with the introduction of autonomy in the provinces, an awakening among both the educationists and politicians to solve them.

Schemes and reports and theories are coming out from all directions, but no single agreed solution can be evolved out of these. It is therefore at a very opportune moment that Mr Richardson has come out with his own ideas on the subjects, and his points of view deserve to receive more than passing notice.

The primary needs of the Indian people are the simple necessities of life: food, clothing and adequate housing. In the last resort the solution of these problems, says the author, depends upon a new social adjustment which will make a more equitable distribution of the resources of the country, thus allowing the ordinary man and woman to live a tolerable existence. But until the ordinary man and woman has some conception of the problems themselves and of what an equitable settlement might be there is very little hope that such a settlement will be reached. . . ." It is therefore on this level that adult education can do its greatest service by opening the eyes of the people, not only to the abuses of those in power over them, but to the much more constructive field of activity wherein they may learn better methods of ordering their social and economic life," the constructive field of activity including such things as improved methods of agriculture, handicrafts of all sorts, improved methods of building houses, and so forth. "In a country as poor as India it is essential that any form of mental and spiritual enlightenment must be accompanied by economic improvement." Mr Richardson also makes it clear that "this does not, however, for a moment preclude the higher forms of education, but rather directs them into those channels where they may be of the greatest practical use to the masses." The author of the paper also raises the question of the Indian National Congress programme of spinning, weaving and other similar handwork which would, according to it, do away with the major economic problems of the country. This point was adequately dwelt on by Prof. M. N. Saha, F.R.S., in the columns of *Modern Review* of September 1938 under the caption "Philosophy of Large-Scale

Industrialization." In these days of ever-increasing industrialization and mechanical power, it shows utter disregard of realities to suggest that age worn, primitive methods would still hold their own and tackle the economic problems of the people.

We must, therefore, remember that the role of adult education in India is to improve the economic position by the proper methods as well as the cultural and intellectual level of the ordinary citizen. It must also be borne in mind, as Mr Richardson points out, that " adult education is no easy high-road to the solution of India's problems, but it is the only possible way that her citizens can be brought to the point whence they may survey the difficulties before them and plan out how to meet them."

Exhibition of Photographic Reproduction of Documents

An exhibition illustrating the photographic reproduction of documents was held recently in the Science Museum, Kensington in connexion with the visit of the International Federation of Documentation for its fourteenth Congress, held in Oxford and London from September 21-26.

The photographic reproduction of documents has great application in several directions, among which the most widely used are based on the possibilities afforded by photographic methods of both rapid and faithful reproduction. Recent developments in the use of miniature film cameras, employing standard cinematograph size or substandard home-cinematograph size films, have drawn attention to the advantages provided by such apparatus for both cheap and space saving reproduction of documents. Also, the use of non visible, *e.g.*, ultra-violet, illumination in photography permits details, which are obscure or quite invisible on original documents, to be revealed clearly on the photographic copy. This last advantage has many applications, for example, in criminology and in the examination of palimpsests.

In view of these, the exhibition was certainly of very importance and of great use to the scientist. It was arranged to present to the public view many types of apparatus for the photographic reproduction of documents, suited to both occasional and extensive use, and adapted to varied requirements. It comprised several original types of cameras and projectors, adapted to both amateur and professional use. Some of the apparatus is arranged to utilize standard commercial general utility miniature cameras. Other cameras shown are designed specifically for the purpose of book-reproduction in whole or in part—in reference libraries, together with the corresponding projecting apparatus for magnifying the film images to enable natural size or enlarged images to be viewed or prints to be made.

Finally, there were exhibits illustrating the use of photographic apparatus specially designed to provide at cheap rates both single and multiple copies of documents without reduction of their natural sizes.

The Oldest Relative of Man

Writing in the *Field Museum News*, D. D. Davis draws attention to the tree-shrew whose specimens were collected by Dr W. H. Osgood last year in French Indo China. "This rare animal, the pigmy tree-shrew (*Dendrogale*), had been known only from conventional museum study skins until Dr Osgood brought back a skeleton and a complete specimen preserved in liquid." It is well known that a group of squirrel-like, but insectivorous mammals, the tree shrews, living in Malaysia, represent an ancient group of " living fossils " that has survived relatively unchanged down to the present day, and they can be, in a sense, said to be the oldest living relatives of the human race. For many years it was believed that the rare pen tailed tree shrew had changed least, and so it had the distinction of being considered man's oldest living relative. But the *Dendrogale* specimen, discovered by Dr Osgood, has been studied and found to be even less specialized than the pen tailed tree-shrew, whose position it can be said now to have usurped.

Mysorean Sculpture Art in the Middle Ages

In an interesting article in *Discovery* of May, 1938, Winifed Holmes describes in a vivid manner the exuberance and grandeur of medieval sculpture in Mysore. The Middle Ages from the 10th to the 16th centuries appear to the author to represent the period during which

Mysore's greatest contributions to Indian art were made. He divides this into three sub-periods: (1) the semi-classical Jain period of the tenth century represented by colossal Gomata figures; (2) the Brahmanic Hoysala period of the 12th and 13th centuries, of which there are many beautiful and floridly carved temples all over the State; and (3) the Vijayanagar period—late 15th and early 16th centuries which introduces into Mysore a baroque Renaissance style of flat relief—grotesque, mock-archaic, paying lip service only to religion, and displaying instead an obsession with the drama and the dance. The author describes the peculiarities and characteristics of each of these three phases. The accomplished technique and virtuosity, he points out, combined with local idiom displayed in the reliefs at Halebid, Belur, and Somnathpur, not to speak of many other less known Hoysala temples, must have had their roots in a long tradition of native craftsmanship which certainly would have been used to the glory of Buddha. "The fifteenth and sixteenth century renaissance in the Vijayanagar period, and incursion into the baroque was India's last flare-up of sculptural inspiration. Long before, the spread of Islam had destroyed the spark and much of the actual creation in Northern, Central and Eastern India. Hindu Vijayanagar kept its tide at bay in the South and West till the end of the 16th century, but after its fall Hindu art flickered and died down. And on top of Islam came the alien ethos of Europe to blow it out altogether. Will it flame up again? Surely the inspiration of a growing national consciousness and common purpose will rouse the remarkable plastic genius of India."

Bi-Centenary Celebration of the Birthday of Herschel

The bi-centenary of the birthday of one of the most eminent names in the whole history of astronomy will fall on the 15th November, 1938. Sir Frederick William Herschel, born in Hanover in Germany on Nov. 15, 1738, was in his early days a bandsman who finding the rigours of the Seven Years' War in Europe too much for him, migrated to England in 1752. Here he rapidly attained popularity and distinction as a musician of note. He had all through been interested in astronomy and a keen observer of the heavens, and as an amateur observer through the telescope, he discovered the planet Uranus in 1781. On the night of March 13, 1781, Herschel directed his own hand-made telescope to that part of the heavens in which Uranus was lying at the time, only to see something interesting. The result was the finding of a new and unknown planet. It is certainly the most important discovery in the whole history of astronomy, in as much as it was the first planetary discovery. Herschel now leaped to fame. He was elected a member of the Royal Society which also awarded him the Copley Medal in November 1781, and was appointed King's Astronomer by George III. He spent the remaining part of his life in the study of the heavens. He was knighted in 1817. Herschel died on August 25, 1822 in his eighty-fourth year.

Besides the discovery of Uranus, there are a large number of various other contributions of Herschel to the science of the stars. We quote the following from *The Telescope* of Sept. and Oct. 1938:

"Herschel was the first to prove that the sun is not fixed in space, but that the whole solar system moves with a velocity approximating that of the earth in its orbit. In 1802 he demonstrated the existence of physically associated binary stars—the discovery of which enabled us to weigh the stars. But the chief object of his surveys was to determine the structure of the stellar system, and his star gauges gave us the first crude estimate of the size and shape of our galaxy as a flattened disc, in which the sun is placed near, but not quite at the centre. He was led to believe that the galactic system was strictly limited in extent and was only one among many such systems. Finally, his catalogue of nebulae was the first systematic survey of those interesting objects."

The Tenth Satellite of Jupiter

Jupiter has been known for some time to have nine satellites. Four of these have long been known to the scientists and were indeed familiar to Galileo, and the remaining five were discovered during the last fifty years. Two more of Jupiter's satellites, bringing the total number to eleven, have been newly discovered. The positions of Satellite X have now been computed on a preliminary basis though nothing about the other one can be said with any degree of accuracy beyond the fact, also based on conjecture, that it cannot be less than ten million miles from Jupiter. About the information so far available regarding the positions of Satellite X, we quote the following from the *Nature* of September 24, 1938.

"These preliminary investigations were made by Dr M. Davidson, who assumed, in the computation of the orbit of Satellite X, that this was practically circular. While going to press a Harvard Card announces that two different orbits for Satellite X have been computed, the results of which have been communicated by Prof. E. I. Yowell of the Cincinnati Observatory. The figures in round numbers are as follows: The first orbit, which indicates that the motion of the satellite is direct has a very high eccentricity, 0.6362, the semi-major axis being 5,900,000 miles. This implies that the satellite makes its closest approach to its primary at a distance of 2,150,000 miles, its greatest distance being 9,650,000 miles. The other orbit shows an eccentricity 0.6207, motion retrograde, and the semi-major axis 18,310,000 miles. If this be correct, the satellite would approach Jupiter to a distance of 6,945,000 miles, and would recede to 29,675,000 miles, the time to complete a revolution being more than 2¾ years. The fact that two such diverse orbits can be deduced from the same data shows the great difficulty of attaching much importance to the elements which are based upon a short time interval."

Social and Physical Sciences

Why do the social sciences continue so backward while at the same time physical and biological sciences have moved forward with unprecedented rapidity in the past 100 or 150 years? This is the question we often hear being asked. To this an answer at some length has been attempted by Joseph Mayer in the pages of *The Scientific Monthly* of June 1938. It is well known that social sciences depend to a large extent on the physical and biological sciences. For an understanding of social relations, whether political, economic or more general, it is necessary, first, to have a sound understanding of the environment in which the human being finds himself, which is the task of most of the physical sciences, and, secondly, of man himself, that is, of his biological and psychological limitations and potentialities. Such an understanding was impossible until biology and psychology were far enough along the road of modern scientific development. So social sciences had to wait till the physical and biological sciences had sufficiently developed. The early misconceptions engendered by the Greeks and the ancients had to be replaced by the correct and scientific truths which came about in the case of physical sciences first, and then by the biological sciences. Whether the study of social relations will now advance as rapidly as the other sciences, we do not know. "Only as we reach down into all the sciences that are antecedent and utilize them for the task ahead, can we hope some day to have as clear an understanding in economics and government and sociology as we have long since secured in the physical and in the biological sciences."

Science in Industry

New Types of Radio Valves

With a view to manufacturing cheap but reliable radio sets investigations have been proceeding in Germany for sometime past on the construction of new types of valves which would combine in the same and one valve different functions. As a result of these researches, the new E series of valves have been introduced in the markets of Germany, consisting of thirteen types of valves, nine of which are of metal construction and the remaining four of glass. The valves are all fitted with a new eight pin base, which is so constructed as to have the grid leads separated as much as possible from the cathode and anode leads. There is also arrangement for screening the two groups of connecting leads from one another.

The chief difference between the metal valves and those of the usual types lies in the fact that the electrode systems of the former are mounted horizontally instead of vertically. The valves are therefore wider in diameter and shorter in height than the usual types. The electrodes are shorter in length and the clearances between the electrodes are considerably reduced. The consumption of the heater is also appreciably low. These metal valves are being used in comparatively costly sets but there is favourable possibility of these being used in cheap " People's Sets."

Of the new glass bulb valves, types VCLII and VY2 are specially meant for use in cheap popular sets. The first valve VCLII is a combination of a high amplification triode and an out put tetrode. The use of this valve enables one to dispense with transformer coupling and thus effecting an appreciable reduction in cost. The triode portion of the valve has the high amplification factor of 65 and the tetrode the high mutual conductance of 5 MA/V giving an output of 0.8W for 3V input.

The second valve VY2 is a small half-wave rectifier for H. T. supply and is very similar to a small detector diode. It gives maximum rectified current of 25 MA.

It is expected that these new types of valves will effectively reduce the cost of construction of cheap but reliable radio sets.

New Sterilizers

The Swiss botanist, Von Nageli in 1893 observed that water in contact with metallic copper acquires the properties of a disinfectant. Later, he observed a much higher effect with the metals, silver and mercury. This action has now been definitely shown to result, according to the *Canadian Chemistry and Process Industries*, from the oxidation of the surface of silver in contact with air, oxygen and carbonic acid and the consequent ionisation or colloidal suspension of the thin oxidized layer in the liquid. Moderately high temperature greatly increase this sterilizing action. The amount of silver coming into action is generally one part per hundred million parts of liquid treated and this small silver content after splitting into ions interfere with the life process of the bacteria which may number one hundred thousand per cubic centimeter. This oligodynamic action of the metal has been applied to preservation of fruit juices and recently to sterilization of water and other liquids on a large scale.

It will be interesting to note here that resins which are completely insoluble in water have also been found to extract all dissolved solids contained in the water and even kill dangerous micro organisms. The process consists in passing water through a type of synthetic resin which removes the metallic ions of calcium, magnesium etc., and then through another type of

resin to remove the acid ions (sulphates, chlorides), which resin has also been found to exhibit a germicidal action. No explanation of the phenomenon has been offered except that of molecular adhesion on the surface of the resins. These synthetic resins can be regenerated by pouring through a dilute solution of an acid in the case of the first and an alkali in the case of the second. The resins are slightly improved by constant working and never wear out.

This discovery at the National Physical Laboratory of England affects every industry using water, the textile industry, the chemical industry, the paper industry and all those concerned with raising of steam, purification of drinking water and control of stream pollution with sewage. It will now probably be possible, by modifying the resin slightly, to extract easily certain substances, for example radium, present in minute amount in vast masses of useless matter. Already large plants are being erected in England for applying this laboratory process to millions of gallons of water.

New Compounds for Inducing Sleep

Watermann in Holland discovered that divinyl ether was advantageously a non-toxic anaesthetic. But its use was restricted as it polymerised on standing. Recently Dr A. C. Cope and Dr E. M. Hancock in a paper at the American Chemical Society elaborates a series of barbituric acid derivatives which contain substituted vinyl groups introduced through methyl ethyl and methyl propyl ketones. These derivatives mark another step forward in the search for sleep inducing compounds which are relatively non-toxic and are not habit-forming. The synthesis is carried out in three stages. Condensation products of aliphatic ketones with malonic and cyanoacetic esters when treated with sodium, a sodium alkoxide or sodamide are isomerised into sodium derivatives of substituted vinyl esters. One substituted vinyl group persists when dialkyl substituted esters were prepared. These esters were subsequently condensed with urea and its derivatives to give the new compounds. The structure of the vinyl group and the nature of the other alkyl group present determine the period of sedation.

Quick Aging of Liquors

According to a patent in Germany submicroscopic particles of silver will rapidly age whiskies, brandies, wines and also will mellow perfumes. In the case of liquors it is fed through a chamber coated with silver and containing a gravel like material coated with the same metal. The liquid is run continuously and it picks up infintesimal bits of silver. In another method the chamber contains two silver electrodes. A weak current knocks off fine silver particles. In short time the alcoholic beverages assume a rich mild taste. To mature perfumes by this "silver" method no odour fixatives as musk and ambergris are required. The perfume besides being endowed with rich fragrance possesses sterilizing properties also. It is disclosed in the patent that this method is in successful operation in a number of German brewing firms.

"Wool" from Rayon

In the method of spining cuprammonium silk the fine filaments coming out of the thin nozzles under pressure are washed and dried or dehydrated in the ordinary manner. But if alcohol is used to remove water from them, a new textile fibre possessing warmth, softness, elasticity and strength approaching that of natural wool is obtained. This process of dehydrating requires a series of baths containing alcohol of increasing concentration, from 30 per cent to 95 per cent, through which the filaments are passed in succession after they are spun. This claim of preparing 'wool' from rayon has been disclosed in a patent issued in Germany.

Conditioning Plant Growths

Dr J. Voss of Kaiser-Wilhelm Institute reports that under ordinary 500 watt nitrogen filled metallic-filament lamps an effective growth of plant in greenhouses has been observed. Neon tubes produced the same effect but high pressure mercury vapour lamps did not continue the effect as sometime later it gave a lag. Inferior results were found with sodium vapour lamps and for destructive effects the unfiltered rays of the quartz mercury vapour came in. Another interesting phenomenon in this connection is that of ethylene gas hastening the ripening of fruit. Subsequent investigations have shown that even the fruits, that ripen early in the season, when placed beside those that ripen later, the latter become ripe earlier. Late Professor Hans Molisch on the basis of these observations conducted further experiments. He reported the

growth-retarding effect by a ripe apple which was placed in a jar containing sprouting seeds of a common vetch (bean) and pea. Astonishingly if the apple is allowed to remain for a short time, accelerated growth takes place. Similarly other fruits, pears, plums and peaches, oranges, lemons etc., and even apple peelings, eyes of potato stunted the longitudinal growth. But roots of some plants, carrots, red beets, have a stimulating effect. Falling of leaves have also been hastened by apples in the case of privet, pea vines, elder etc. and this influence has been extended to the case of blossoms which opened early. All these are explained to be due to the gas exuded by these bodies. These results of the experiments will be soon exploited by the agri cultural industrialists in the West. Added to these investigations is the discovery of the length of-day in fluence on flowering, fruiting, growth and maturity of plants. The length of day is decreased by removing the plants from exposure of day light and increased by means of ordinary forty watt bulbs. The credit for this discovery goes to Dr W. W. Garner and Dr H. A. Allard, at the Arlington Experiment Station in the U. S. A. They obtained flower long ahead of the season, secured radishes five inches in diameter by keeping the plants from going to seed for two years and caused trees to retain their leaves all winter and produced normal leaf fall in midsummer by artificially producing and controlling the seasonal changes in the length of day.

Institute of Plant Industry, Indore

The work done at this Institute and by its Extension Officer in organising practical demonstrations at fairs and exhibitions are improving the lot of the agriculturists in the Central India and Rajputana States, where the propaganda work has been concentrated recently.

Attempts have been made in the various States like Sikar, Khetri, Dewas S.B., Dewas J.B. and Ajmer-Merwara to improve the breed of cattle by selecting bulls locally or by importing pedigreed bulls and distributing them in the villages. Cattle breeding stations are established at Indore and Jaipur, while Jodhpur is maintaining a separate department for this work. Attention is also being paid to silage-making and to other cattle feeds like lucerne or mangold.

For increasing the fertility and physical texture of the soil rain watered compost is being taken up in most of the States, while the method of composting municipal wastes is well established in others. In some of the States bone-char is prepared to augment the supply of fertilizers. The Sikar State has stopped selling bones on contract at the cost of its general revenue so that they may be freely used.

Use of improved varieties of seed has been encouraged by the distribution of seed of Malvi-9 cotton in the Malwa States, Cambodia, Indore 1 in Jodhpur and in the light soils of Ajmer-Merwara, while C. 520 is being rapidly introduced in the States of Rajputana. Heating of cotton seed is recommended to check the attacks of the pink bollworm. Efforts are also being made to improve the cultivation of other crops like groundnut, bajra, paddy, gram, barley and maize by the introduction and spread of new and improved varieties. Large areas in Jaipur, Jodhpur and Ajmer-Merwara are covered by Punjab wheats C. 591, 8A, and 9D.

Zarda and cigarette tobacco types have become very popular in most of the States and a simple method of curing leaves under grass is taught to men under training at the Indore Institute. Soyabean unknown in the local market until recently is now being introduced and there is a big demand for it from Bundi, Dewas and other States.

Co. 290 sugarcane has replaced S. 48 and is very popular in most of the States. Improved methods of growing sugarcane are also being introduced. Sindewahi furnaces are now in use in most of the Central India and Rajputana States and the services of the Institute staff and trained gur-makers are made avail able to the member States for advice. Sugar factories are established in most of the States and sugarcane from adjoining areas is absorbed in these factories.

Cultivators have taken to the use of improved implements like the Kans plough, the Meston plough and the Indore Ridger, which are in great demand every year. Digging fork, hand chair cutter, gur boiling pans, seed drill and bakhar are being recommended in States where their use was not even known. Seed storage in air-tight godowns, and distribution of seed on the Sawai system has been taken up in Alwar.

The Properties of Cotton Fibres which make a Good Yarn

K. R. Sen

A good yarn must have several characteristics. In this discourse it is intended to consider them in relation to the particular fibre properties on which they depend, and to suggest possible ways of improving the yarn spun from a particular material. All workers on cotton agree that the principal requirements of a good yarn are as follows:

In order that a yarn may stand the stress and strain of the weaving process and also that it may produce sufficiently strong and wear-proof fabric, it is necessary that the yarn must have at least some difinite minimum *strength* as well as *extensibility*. The stronger the yarn the better it is for any purpose. In addition to the question of strength and extension, the property of yarn which is equally important, is the regularity of diameter or *evenness*. Not only does this property help the yarn in attaining a uniform strength, but yarns with regular diameter also produce an even effect of any shade of colour on dyeing. It is also necessary that the yarn should be *free from 'neps'* or clots of tangled fibres. Neppy yarns produce very bad dyeing effect, as the neppy portions absorb less quantity of dyestuff than others. Again, it must also be possible to produce *fine* yarns from a material in order that fabrics constructed out of them may satisfy modern taste. Apart from these requisites of a good yarn, it is also necessary to consider that the material is not *too wasteful* during processing to be economically suitable.

Researches on cotton have been able to indicate to a large extent the properties of fibres relevant for manufacturing yarns, as well as how to attain suitable values of those properties by cultural control.

Considering first of all, the question of *fineness* of yarns, it is common knowledge that fineness is measured by 'counts' which indicate the number of times a measuring tape, or 'bank' of 810 yards will lie on 1lb. of yarn stretched from end to end. Naturally, the finer the yarn the higher is the count. It is now definitely known that for Indian cottons, which consist of both fine and coarse varieties, length of the fibre as well as its mass per unit length are the factors which best determine the counts. This result has been established[1] by using the statistical method of regression on a large number of observations. It is found that fineness of yarn increases as the fibres become longer and their mass per unit length smaller. It is now even possible to approximately predict from fibre properties the count of a yarn which would be the highest suitable for the purpose of its use in the "Warp". Now, any mill which desires to keep up its standard of quality of yarn spun from a highly variable material like cotton, can hardly work with a single variety. They must *mix* two or more cottons to maintain the quality economically. In selecting cottons for mixing, the mills generally concentrate upon the difference in fibre length of the components. But recent work[6] has definitely indicated that difference in fibre length is of far less importance than difference in the characters of fineness. Attention should therefore be fixed on the qualities of ribbon width and mass per unit length of fibres in selecting the components of a mixture. It is also found that when one component is of very long and fine type, introduction of a small proportion of somewhat coarser cotton in the mixture will produce stronger yarns than what the long and fine cotton alone would do. Thus it is difinitely established that whenever a cotton or a mixture of two cottons is spun, the quality of fineness of fibres should be considered too important to be neglected.

As regards yarn *strength* it is now possible[2] to predict its value for single thread at any count fairly accurately from a knowledge of the length, the mass per unit length and the breaking strength of fibres. The equation for this purpose stands as:

$$Y = A.\ l/c.\ s/m\ (1 - E)$$

where Y = the single thread strength,
l = the fibre length,
c = yarn fineness,
s = the breaking load of fibres,

m the fibre mass per unit length,

and E the proportion of loss of strength due to the peculiarities of yarn structure and the nature of material.

A is a constant which equals 5.291×10^{-4} for cotton yarns when c is measured in counts, l in inch, s and Y in oz. and m in oz. per inch.

The actual stresses and their distribution in a yarn can hardly be ascertained fully; for, they will vary from yarn to yarn inspite of similarity of the apparent characteristics. Apart from this, considerable variations will also occur from point to point of a particular yarn, such as cannot be definitely assessed or controlled. It is therefore impossible to determine E directly from the fibre properties. E can however be estimated by comparing the strength due alone to the full quota of fibres, with the observed strength of the spun yarn. In this way by using the observed values for a number of pure varieties of cotton of a particular season, it has been possible to construct an *arbitrary* scale of E for different count-groups corresponding to different scales of intrinsic strength, s/m, of fibres. The scale of E so constructed is stated in Table I.

TABLE I

Count groups.	Intrinsic strength. s/m ($\times 10^6$)	E
>40's	$\geq$ 0·85	$\frac{1}{3}$
	< 0·85	negligible ($\simeq 0$)
31's to 40's	$\geqq$ 0·85	$\frac{1}{2}$
	< 1·85	$\frac{1}{3}$
16's to 30's	> 1·20	$\frac{2}{3}$
	0·85 1·20	$\frac{1}{2}$
	<0·85	$\frac{1}{3}$
6's to 15's	> 0·84	$\frac{2}{3}$
	0·71—0·84	$\frac{1}{2}$
	<0·71	$\frac{1}{3}$

It will be seen from Table II that the values of yarn strength calculated with the help of this scale of E, agree very closely with the observed values. Some discrepancies in certain cases are of course quite expected in view of the high probability of sampling differences as well as the arbitrary nature of construction of this scale. It is found that the strength of mixtures of two cottons can also be predicted by the use of the equation given above, if we regard that the mixture is practically homogeneous thus possessing the weighted mean fibre qualities. Results obtained for several mixtures are also stated in the table.

The relation of yarn strength with counts and the fibre properties of length mass per unit length and breaking strength qualitatively recorded from experimental observations by Kapadia[3] and Ashton[4] respectively for cotton and staple fibre, fully agree with the conclusions available from the present equation. The direct dependence of yarn strength on the intrinsic strength, s/m, of fibres as is evident from the equation, was also strongly suggested by Balls[5] in his book.

As the yarns become finer it is found that the *extension* under breaking stress decreases. Now, this property of the yarn is greatly dependent on the binding effect of twist. As the counts increase making the yarns finer, the number of turns per unit length increases. Following upon this there is an increase in the total clinging power which induce increased resistance of the fibres to relative slippage. Again, as the diameter of the yarn decreases at the same time, the directions of the twists turn more and more away from the axis of the yarn. As a result, the resolved part of the tension decreases along the fibre, while it increases in the direction normal to the fibre. Thus fibres under increasing angle of twist become more and more unable to over-come the increased resistance to slippage while at the same time they become subject to better grip by the twists through compression. In consequence, for higher counts the fibres cease under tension to attain a position parallel to the axis of the yarn prior to the breaking of the latter. Thus extension becomes less as finer counts are spun.

Balls[7] showed that the *irregularity of yarn diameter* must be due to the mutual resistance of the fibres to slippage during drafting. Yarn strength, we know, indicates the strength of the weakest portion of the yarn within the test length. Thus as a result of "drafting irregularities", thick and thin places must frequently occur resulting in irregularity of breaking strength. Now, it is found[8] that yarn strength irregularity is very largely controlled by the clinging power of fibres. This dependence of yarn strength irregularity on clinging power is observed also in the case of staple fibres as well as their mixtures with cotton. The important function which clinging powers play in determining yarn strength irregularity helps

TABLE II

Single Thread Strength (oz.), for count.

	COTTON.	8's Obs.	8's Calc.	10's Obs.	10's Calc.	12's Obs.	12's Calc.	14's Obs.	14's Calc.	16's Obs.	16's Calc.	20's Obs.	20's Calc.	24's Obs.	24's Calc.	30's Obs.	30's Calc.	34's Obs.	34's Calc.	40's Obs.	40's Calc.
	A—PURE																				
	Surat 1027 A.L.F.	..	..	..	..	..	..	..	..	..	..	13.9	13.0	..	..	8.0	7.8	..	..	5.7	5.9
	Jayawant	..	..	..	..	..	..	..	..	..	..	13.1	13.0	..	..	8.8	8.7	7.7	7.7	..	..
	Broach Palej	..	..	16.8	15.9	15.4	13.3	11.6	11.4	..	..	..	..	..	..	..	..	..	..	..	..
	Wagad	..	..	..	..	16.4	15.7	12.2	11.8	..	..	..	..	..	..	..	..	..	..	..	..
	P. A. 4F	..	..	..	..	..	..	..	..	14.4	12.2	11.7	9.7	8.7	8.1	..	..	..	..	..	..
	Khamgaon	18.7	19.3	16.6	15.4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	B—MIXTURES																				
With Surat 1027 A. L. F.	25% Broach Palej	..	..	..	..	..	..	..	..	..	..	11.8	10.9	10.1	9.0	8.0	7.2	6.5	6.4	..	..
	25% Wagad	..	..	..	..	..	..	..	..	..	..	13.3	10.3	9.8	8.6	7.6	6.9	5.8	6.1	..	..
	25% 4F	..	..	..	..	..	..	..	..	..	..	12.4	11.2	9.8	9.4	7.7	7.5	6.1	6.6	..	..
	25% Khamgaon	..	..	..	..	..	..	..	..	..	..	12.0	10.7	9.8	8.9	6.6	7.1	5.9	6.3	..	..
	50% Broach Palej	..	..	..	..	..	..	..	..	..	..	12.1	10.3	8.1	8.5	6.2	6.8	..	..	..	..
	50% Wagad	..	..	..	..	..	..	..	..	..	..	10.3	12.1	9.1	10.1	6.4	8.1	..	..	..	..
	50% 4F	..	..	..	..	..	..	..	..	..	..	11.6	10.7	9.8	8.9	6.7	7.1	..	..	..	..
	50% Khamgaon	..	..	..	..	..	..	..	..	..	..	10.9	9.7	8.5	8.1	..	..	..	..	..	..
	75% Broach Palej	..	..	..	..	..	..	..	..	12.2	14.1	13.0	11.5	7.5	9.5	..	..	..	..	..	..
With Jayawant.	25% Broach Palej	..	..	..	..	..	..	..	..	..	..	12.8	12.3	11.0	10.3	8.6	8.2	..	..	..	..
	25% Wagad	..	..	..	..	..	..	..	..	..	..	11.4	12.1	9.8	10.1	8.3	8.1	..	..	..	..
	25% 4F	..	..	..	..	..	..	..	..	..	..	10.8	13.0	9.6	10.9	7.9	8.7	..	..	..	..
	50% Broach Palej	..	..	..	..	..	..	..	..	..	..	9.7	11.9	9.6	9.9	..	..	..	..	..	..
	50% Wagad	..	..	..	..	..	..	..	..	..	..	10.2	11.1	8.8	9.2	..	..	..	..	..	..

us to consider that the regularity of yarns can possibly be improved by carrying out drafting under high humidity while actual spinning is conducted under low moisture conditions. This should happen because, as shown in a recent work,[9] clinging power is greatly reduced by increasing the humidity.

It was mentioned earlier that presence of '*neps*' resists uniform dyeing of yarns. This is due to the fact that the neps consist mainly of extremely thin-walled or what is called 'immature' fibres rolled up into tangled mass during processing and drafting. The cellulose content of these fibres being low they absorb very little of the dyes, and so present a lighter shade than the surroundings. Neps cannot be totally avoided, but may be reduced by diminishing the nep-forming potentiality of the material. This reduction can be effectively carried out by growing cotton under proper cultural conditions combined with suitable selection of the picking time. Judicious administration of water during the period of boll-formation controls production[10] of thin-walled fibres. On the other hand, high humidity and low temperature acting together lead[11] to production of large proportion of immature fibres. It is therefore necessary that in addition to growing the crop under proper cultural control, the collection of the open bolls should be executed separately during the favourable and the unfavourable periods, if it is desired to exercise suitable control over the proportion of immature fibres in a material.

Wastiness of cotton depends partly on the freedom of the material from dirt and extraneous leafy matter, and partly on the presence of a high proportion of 'short' fibres *i.e.*, fibres possessing a length less than the three-fourths of the most frequent length of the material. This proportion can be easily estimated[12] from sorter results. These short fibres act in this manner because the machinery adjustments which are made according to the most frequent length of the material are unsuitable for their proper control. Loss incurred in carding a cotton is mainly due to the entangling of fibres among the pins. This loss may run very high unless the proper sort of card is selected. The entangling is naturally higher for those fibres which possess greater pliability— a property controlled largely by the mass per unit length. In the case of the mixture of a long staple cotton with a short staple one, if there is large difference in fibre mass per unit length of the components, there is a great likelihood of the carding loss of the mixture being increased.

From this discourse we thus learn that:

(*i*) the cotton selected should be sufficiently clean with low proportion of short fibres and preferably of low fibre mass per unit length in order that it may not be wasteful;

(*ii*) in order that the cotton selected may yield *fine yarns*, attention should be directed to low mass per unit length of fibres as much as to large fibre length. For selecting cottons for mixing, the difference in the qualities of ribbon width and mass per unit length should loom larger in importance before one's eyes than that of fibre length.

(*iii*) in addition to possessing considerable length and fineness, the fibres should also possess adequate breaking strength in order that the yarn may be sufficiently *strong;*

(*iv*) the cotton should be spun to a suitable count so that the thread may yield sufficient *extension;*

(*v*) the fibres of a cotton should be as slippery as possible to minimise *yarn strength irregularity;* and

(*vi*) a cotton containing as low a proportion of thin-walled fibres as possible should be selected so that the yarns may be largely *free from 'neps'*. In this respect good co-operation among agriculturists, merchants and industrialists is necessary.

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MEDICINE AND PUBLIC HEALTH

Public Health in India

The Report of the Public Health Commissioner with the Government of India for the year 1936, which has just been issued, is, as usual, full of informative details and is well worth careful perusal by all public health workers in this country.

"Since 1931, when the last census was taken", states the Report, "India has remained comparatively free from violent out-breaks of epidemic diseases and, during the same period, the annual balance of births over deaths has been consistently favourable to progressive increase of the population. During 1936, the number of births was 282,349 higher than that for 1935; on the other hand, the number of deaths was less by 202,980, so that the estimated population for 1936 shows an increase of about 3,600,000 as compared with that of the previous year". Although there was some decrease in the death rates for cholera and plague, there was an increase in mortality from small pox by 16% over that of the previous year. Death from "fevers" declined by about 4%, while that from respiratory diseases, dysentry and diarrhoea recorded an increase.

Of 6,400,000 deaths in India in 1936, 160,000 were from Cholera, 13,000 from Plague, 3,600,000 from the heterogeneous group known as "Fevers", 280,000 from Dysentery and Diarrhoea, 490,000 from respiratory diseases and 1,730,000 from all other causes.

This state of affairs cannot be discribed as encouraging, for, in the West, during the last 60 years, there has been a large decline of mortality and a great progress in raising the general standard of health. The total number of deaths during the year in India was 6½ million. The birth-rate per mille was 35.4 and death-rate 23 per mille. The birth rate per mille based on the married female population between the ages of 15 and 40 in British India was 212.5. This figure is almost double that in England and Wales. Thus, in spite of the high mortality rate, the high fertility rate is contributing to the growth of population, which is expected to number 400,000,000 by 1941.

The infantile mortality rate stood at 162 per mille. The figure for New Zealand stands at 32 per mille. Of 46 countries of the world for which infantile mortality figures were available for 1935, 40 recorded rates lower than that of India, indicating the backwardness of India as regards protection of infant lives.

About 49% of the total mortality in a year is among those who are below ten years of age, while the corresponding figure for England is only 12%. During the first year of life, India's proportional mortality is about 3½ times that of England. Between 1 and 5 years, it is 5 times greater and between 5 and 10 years, it is three times as high. About 25% of the total deaths were among infants under one year, while the corresponding English figure is 7%. Women in England at all ages have a lower mortality rate than males, while in India the female death rate exceeds that of the male during the reproductive years, *i.e.*, between 15 and 40 years of age.

It makes a painful reading to find that while the death rates in other countries are diminishing and the longevity is increasing, India relates a sorry tale from year to year. The writer of the Report, Col. A. J. H. Russell, a very able officer of the Indian Medical Service, realizes the position and opines that "in India, the solution of the problems associated with physical health and social environment is complicated by the evils of ignorance and poverty to which is commonly added a fatalistic outlook arising, it may be, from the low standard of life which has been the experience of

so many generations past. In a country like India, indeed, where the staple industry must continue to be agriculture, an industry largely dependent for its success on monsoon rains, well known to be painfully raviable it is an unfortunate fact that economic stability is almost impossible of achievement. In making that statement, it is not forgotten that large and small irrigation projects have relieved the situation in different areas and that the development of other industries has given considerable relief to a percentage of the population. Even so, the main task lying before Indian Governments is the organisation of rural life so that the villager may become more self-reliant and self respecting and that he may be led to a healthier and happier life. The progress of the country is so bound up with the welfare of the agricultural population that it is not surprising that within recent years increasing attention has been paid to this subject both by politicians and social workers.

The problem of the increase of population at the rate of 35 to 40 millions per decade is no less embarrassing, especially in view of the low standard of life, the question of food production and the toll of life and suffering from preventible diseases. The task that confronts India is not academic one; what is required is that the present low standard of living should be definitely raised. It is certain that no solution of this vast problem will be reached without concentrated effort and without the active participation of all sections of the community. The resources of this country are immense, but they will become available for the betterment of the people only by a well-planned campaign of economic development.

The reader is curious to enquire why, while other countries in the world were improving their state of public health, India has lagged behind for a century and a half. The Americans say that public health is a purchasable commodity. Why has it not been purchased in India? It is because very little money has been devoted to public health and education out of the public exchequer. Both of them are necessary in securing an economic advancement of the people. The state has taken a comparatively insignificant part in industrialising the country and in tapping the enormous terranean and subterranean resources for the benefit of the people.

We have been able to comment upon only three out of the twelve sections in which the first volume of this interesting Report is divided. We hope to deal with some of the remaining sections in subsequent issues of our journal.

The Influence of Sunlight upon Experimental Tuberculosis *by A. C. Ukil and S. R. Guha Thakurta, Amer. Rev. Tuberc. 38, 448, 1938.*

This work was undertaken to demonstrate the biological influence of sun-rays, if any, in this country upon experimental tuberculosis in guineapigs. In order to eliminate the distinctly harmful heat rays and to utilize the biologically active ultraviolet rays of sun light special contrivances were evolved. The sun rays were filtered through Brephos Blau glass No. 5 which allows the maximum of ultraviolet rays (up to 2,910A°) while cutting off nearly 90% of heat rays. For the experiment a number of guineapigs were divided into 4 groups. Each group contained a number of both inoculated and uninoculated animals.

Group 1. animals confined in cages and exposed to filtered rays of the sun.

Group 2. animals confined in cages and exposed to direct sunlight.

Group 3. animals confined in cages but kept in a well ventilated room.

Group 4. animals not confined in cages but kept in an open enclosure under a shed with freedom of movement to stimulate the natural conditions of free movement of the animals.

Group 3 & 4. —were the controls.

As regards the dose of solar radiation, exposures were commenced from 5 min. and then gradually increased by 5 min. every fourth day until 2 hours, reached. The variations of temperature during the period of experiment were noted every day and a blast of air from a fan was introduced over the animals during the exposure to minimise the effects of heat both from sunlight from above and the radiated heat from the earth's surface below.

The uninoculated animals showed an increase in weight whereas the inoculated animals suffered a loss. The inoculated animals of Group 4 suffered the least loss in weight and among the other groups, those of Group 1 showed a less amount of loss.

The Group 4 animals survived longer while the survival period of the Group 1 was the lowest.

The dissemination of lesions beyond the regional Inguinal lymph node was much less marked in Group 1 and most extensive in Group 2.

Histologically no evidence of fibrosis or retrogression was noticed in the lesions.

The experiments were repeated with shaved guinea pigs and identical results were obtained.

Though the beneficial effect of the ultraviolet content of sun-rays upon experimental tuberculosis was not sufficiently established yet it was remarked that better results would have been obtained if the radiated heat from the earth's surface could be substantially eliminated. The application of solar radiation for therapeutic purposes in this country can be advised only when the effects of heat radiation can be sufficiently counteracted.

P. K. S.

Tuberculosis in India

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Epidemiological Features

The distribution of infection and disease in India presents a complex problem, as the picture varies in different areas from the almost virgin rural and far away places to the highly urbanized and industrialized centres. Tuberculous infection, though increasing in recent years owing to increasing urbanization, industrialization and the introduction of rapid transport facilities, is not yet so wide spread in India to-day as in Europe and America. The urban population in India varies between 7 to 20%, according to different regions, as compared with 80% in England and Wales 52% in U.S.A. and 53.7% in Canada. The infection rate in India is yet only half of that in European countries, and it varies from 21% in rural to 76% in urban and industrial areas. The mingling of rural populations which are much less bacillized and of virgin races like the Gurkhas, Bheels, Khonds and Khasias with people of highly tuberculized areas presents a complex picture of hypersensitivity and resistance among the infected people. The smaller towns and industrial centres serve very often as the meeting ground for the diffusion of infection and disease.

People who migrate from rural areas into cities and industrial centres, particularly students, women, children, menials, labourers and mill hands, usually show a low incidence of infection. When they are attacked with the disease, they show, like the heavily contaminated rural population, an acuter onset and present a more exudative infiltration and a higher death rate than among the urban people. The course of the disease shows an acuter onset and proves more rapidly fatal than what occurs generally in Europe. It has been noticed that both the pulmonary and non-pulmonary forms of tuberculosis attain their maximum age incidence 5 to 10 years earlier than in Europe. The prevailing type of lung tuberculosis in rural and semi-rural areas shows predominantly exudative changes, with very fragmentary attempts at localization. A study of pathological materials by workers in different parts of India has shown that only 5 to 10% of cases studied exhibited any marked tendency to fibrosis, while the remainder showed predominantly exudative lesions and as many as 60% showed extensive bilateral lung involvement. The Anglo-Indians and those who have been born and brought up in the larger cities very often show, however, lesions comparable to those met

with in Western countries, when other factors causing hypersensitiveness are excluded.

The disease process in tuberculosis is determined by various factors which influence resistance or susceptibility to disease. The frequency and dosage of infection influence resistance and susceptibility by their effects on the physique and bodily chemistry. Nutrition, environment, habits and customs also influence the complexion of the problem. Poverty, overcrowding and badly adjusted dietary operate in a large number of cases. Of habits and customs, those of indiscriminate spitting within dwellings, of eating and drinking from common utensils and of sleeping together in the same room and on the same bed contribute to a *large-dose infection mostly on an imperfectly immunized* soil. Fifty per cent of the cases diagnosed in hospital polyclinics give a history of close contact with one or more previous cases in the family. Besides these, social conditions, like the *Pardah* system, early marriage and motherhood, contribute to a considerably higher mortality among young women.

From figures received from the out-patients' section of hospitals, it appears that lung tuberculosis accounts for 63%, glandular tuberculosis for 17% and osteo-articular lesions for 14% of the total cases. Out of 300 strains of tubercle bacilli thus far isolated and typed out in different parts of India, from non-pulmonary lesions, only one has proved to be of the bovine type, the rest being of the human type. It is believed that cattle tuberculosis has a much lower incidence here than in Europe, but the subject is being investigated in greater detail. The invariable practice of boil milk before consumption precludes another possibility of bovine infection playing its role here, as in some European countries. The transmission of tuberculosis in India, therefore, is, in an overwhelmingly large proportion of cases, from man to man and generally within the dwelling houses, particularly in joint-family systems where the homes are generally overcrowded.

The influence of purely climatic conditions upon the prevalence and spread of tuberculosis seems to be of less importance than that of social and economic factors. It may be that the climatic influences act not directly but by modifying the social conditions, such as domestic architecture, customs, etc., among the population exposed to them. The abundant sunshine and the richer thermal and ultra-violet rays here preclude the possibility of dust-borne infection playing the same role as in Western temperate zones with less abundant and less intense sunshine. The study of secondary bacterial flora, aerobic and anaerobic, in pulmonary tuberculosis studied thus far shows that they are richer in India than in the West and that their association with the tubercle bacillus seems to heighten the virulence of the latter.

The question of the incidence of tuberculosis in industrial areas has recently engaged the attention of the Indian Research Fund Association. It is yet too early to state the position with any degree of exactitude, but it is believed that the diffusion of infection and disease is fairly high. The large agglomeration of people within a small area and the conditions of living no doubt contribute to this state of affairs.

Although no accurate figures about the diffusion of tuberculosis in rural areas are available, it appears that rural people who get the disease when they migrate to towns and industrial areas carry the infection back to their village homes and are thus contributing to its spread into rural areas. A recent tuberculosis survey in a rural and semi-rural area of the eastern Himalayas (Darjeeling district) reveals the infection rate to be 34.9% in rural and 47.4% in semi-rural tracts which were at one time thought to be 'virgin soil.' It is significant that the Darjeeling district, within the territorial jurisdiction of which the above findings were obtained, which is not at all industrialized and is chiefly rural, stands only second to Calcutta as regards mortality rate from tuberculosis, in the province of Bengal.

Mortality Figures

It is very difficult to state, with any degree of exactitude, the morbidity and mortality rates from the various forms of tuberculosis in India, owing to manifest defects in the method of registration and notification known to all public health workers in this country. Tuberculosis has been declared notifiable only in municipal areas in certain provinces but there again very few cases are actually notified by the medical profession and public health staff. Faulty diagnosis by practitioners accounts for the wrong inclusion of a large number of cases under the heads of fever, respiratory diseases and the various categories of infantile

mortality. As an instance, it might be pointed out that, although infantile mortality from tuberculosis has hitherto been missed in most municipal records in India, a recent study of tubercular homes has shown that 70 to 80% of the children gave evidence of infection, 15 to 20% showed active pulmonary disease and the tuberculosis mortality rate was 50% higher than the general mortality rate which was already very high in India. The tuberculosis mortality rate among adult contacts was 3½ times that of the general mortality rate. A recent investigation in a part of the Lahore city has shown that only 50% of the deaths from tuberculosis were actaally reported as such, the other 50% being reported under "fevers" and other diseases. The official figures for mortality from tuberculosis in the large towns often range from 200 to 400 per 1,00,000, as compared with 80 to 120 in some of the large towns of England. The figures are the highest in the industrial towns in India. The real figures are certainly higher than these, and it may be assumed that 10 to 20% of total deaths in the larger towns are from tuberculosis. The rural death-rate from tuberculosis, as appears from the present public health records, is half to one-third of the urban rate, but the infection seems to have rapidly diffused into rural areas within the last 3 to 4 decades.

It is believed that the peak of the epidemic of tuberculosis was reached in England as far back as 1830 and in Japan as far back as 1910. India seems to be on the ascending curve of the peak at present, but it is difficult to say with precision when the highest point will be reached, as this will depend on the rate of urbanization and industrialization and consequent diffusion of tuberculosis throughout the country. From comparative epidemiological, clinical and histo pathological studies, some workers (Ukil) in India believe that a major part of the population in India to-day possess an intermediate degree of specific resistance or immunity against tuberculosis between the 'virgin' African (as noted by Borrel and others) and the well-immunized European races and that India perhaps stands in this regard on the same level as China.

Age, Sex and Racial Factors

We have at present practically no records of infantile deaths from tuberculosis, as the diagnostic and registration organizations are not yet properly organized in India. The death-rate in the adolescent period is better recorded in the larger municipal areas. The female death rate between 15 and 20 years is several times (sometimes 5 to 6 times) higher than that of the male death-rate during the same period. Adults in rural areas sometimes shew the childhood type of the disease, while children in urban areas show the adult or even fibroid type of disease. Aboriginal races, races living in the border regions of India and people living in far-off rural areas show more of 'virgin soil' and acuter type of disease than those living in more thickly populated and transport connected areas. Racial factors, by themselves, do not appear to be as important as the isolation and environmental factors, in determining the dissemination and type of disease. The same remark holds good with regard to the diffusion of infection and disease among different communities--Hindus, Mahomedans, Christians and others. With increasing urban conditions, a tendency to a milder type of the disease has been noticed.

Influence of Economic Status

In a recent survey of tubercular homes in Calcutta, it was noticed that, where most of the inmates belonged to the poorer classes, where two-thirds lived in houses with bad hygienic conditions and where 50% had only one-roomed tenements, no correlation could be found between the above factors and the tuberculin reaction and morbidity rate. In a recent study in one of the leading sanatoria in India, practically no correlation was found between poverty and the type and course of disease except perhaps some degree of less severe disease in the well-to do classes, but here again the well-to-do classes has chiefly come from urban centres. It is wellknown that poverty as such has no direct bearing on tuberculosis, except that it causes over crowding and undernourishment. But how far their relative importance operates in this matter can only be determined by more extensive surveys.

Problems of Diagnosis and Treatment

From actual experience at some of the well-conducted tuberculosis clinics, it has been found that only 14%, of cases are in stage I, 32% of cases in stage II and as many as 54% of cases in stage III when they first seek the aid of these clinics. The difficulties of correct diagnosis are partly due to the

ignorance of the public, insufficient training of medical practitioners in tuberculosis and to the type of cases generally met with in a majority of the population, *viz.*, hypersensitive and exudative types of infiltration of lung parenchyma. In the latter, stethoscopic examination does not often reveal evidences of necrosis and breakdown of tissues, so much so that X-ray examination shows multiple and extensive lesions, although there may be very little sputum which may even be T. B. negative in these cases. In well-immunized community, there is better localization of lesions and hence physical signs are oftener more correctly elicited.

As regards treatment, the position is extremely unsatisfactory, chiefly for want of early detection and for insufficiency of beds for the tuberculous. In a province (Bengal), with a population of 46,000,000 where 1,00,000 annual deaths from tuberculosis are estimated, there are only 400 beds for the tuberculous. Fortunately, when these patients are placed under modern institutional treatment, the results seem to be as good as in other countries, except in cases which are very advanced. With a population of 350 millions and an estimated annual tuberculosis mortality of 6,00,000 to 10,00,000, there are only 2,600 beds in the whole of India for the care of the tuberculous.

It is chiefly for want of beds that efforts are being made in India to offer surgical treatment to ambulatory cases attending tuberculosis clinics. It has been noticed that approximately 15 to 20% of cases attending a clinic are found to be suitable for the application of surgical methods (artificial pneumothorax, phrenic exairesis, etc.). Among these cases, 70 to 75% show improvement or 'positive results' and 65% of positive sputum cases become T.B. negative. A large number of patients, who are found to be too ill to be treated as ambulatory cases, are sent back to their homes, for want of beds, to re-infect their household.

It is thus seen that many of the problems of diagnosis and treatment are closely linked with those of prevention.

Problems of Prevention

As early as 1910, Sir Pardey Lukis, the then Director General of Indian Medical Service, stressed the importance of the tuberculosis problem in India. During 1914-16 an investigation was carried out by Dr Lankester, under the auspices of the Indian Research Found Association in the large cities and provinces of India. A large amount of useful information was collected and published in a Memoir in 1918. He came to the conclusion that the disease was definitely on the increase and advocated that the best results would be obtained by a combination of governmental and voluntary efforts. The recent work on the epidemiology and pathology of the disease has been carried out chiefly by Dr Ukil.

As regards the campaign against tuberculosis in India, nothing has so far been done commensurate with the extent and urgency of the problem that has to be faced. In other countries, where well developed tuberculosis services exist, the fight against the disease has been organized as a many-sided attack in which several types of institutions take part, *e.g.*, tuberculosis dispensaries or clinics, hospitals, sanatoria, care colonies, preventoria, etc. What lines India should take is now engaging the attention of different workers.

It is generally agreed that we should begin with the Foundation Scheme or the establishment of clinics or dispensaries, having specially trained Medical Officers and Health Visitors, but with this difference that we are to offer surgical treatment to ambulatory cases more abundantly here than in other countries, owing to paucity of beds. The results thus far obtained, as referred to above, justify its continuance until such time as a sufficient number of institutions is available in this country. The position will be realized when it is said that there are only about 70 clinics or anti-tuberculosis dispensaries in the whole of India to-day.

As regards hospitals, they have to be located in so many warm and humid regions of India, as these centres must necessarily be near the localities which they are intended to serve and as high altitude regions are very often far away from these localities. As regards sanatoria, experiments have to be done in different altitudes but it has been noticed that an altitude of 2,500-4,000 ft. above sea level suits the patients of the warmer tracts well.

As regards care-colonies, India has to devise methods different from those in highly industrialized and almost universally electrified Western countries. Preventoria and open air schools need not present any difficulties in a country where nature encourages an outdoor life.

In the year 1929, two anti tuberculosis organizations were formed in India; (*i*) the Tuberculosis Association of Bengal, which has chiefly followed the United States Tuberculosis Association methods and has developed an excellent organization under the category 'Foundation Scheme,' and (*ii*) the King George Thanksgiving (Anti-Tuberculosis) Fund, which tries to disseminate ideas about prevention by trained doctors and co-ordinates anti-tuberculosis activities throughout India. The movement has lately gathered momentum since Her Excellency the Marchioness of Linlithgow, the Vicereine of India and Vice President of the Papworth Village Settlement, has taken up the matter in earnest and is raising funds to organize co-ordinated activities towards prevention throughout this sub-continent.

Finally, we should like to draw attention to one point. In a country which is still chiefly agricultural and rural and which is slowly but gradually getting industrialized and where large numbers of rural population are drawn into industrial areas and factories, it is worth while thinking whether any reduction of morbidity rate can be achieved by employing the B.C.G. vaccine before they enter the urban and industrial zones or lives.

It may be pointed out that India, which is at the threshold of industrialization, offers an opportune moment for the application of properly thought out and co-ordinated scheme of prevention. The schemes will be rendered more elaborate and the problem more difficult, if timely measures are not adopted.

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Research Notes

How can Thunderstorms affect Upper Atmospheric Ionization

Regular observations on the electron density of Region E_1 of the ionosphere show that there exists some correlation between the occurrence of thunderstorms and abnormal increases in the ionization of this region. It is therefore interesting to enquire how thunderstorms acting within the troposphere can affect the ionization of a region situated as high as 100 km. As early as 1925, Prof. C. T. R. Wilson pictured two processes by which thunderstorms might influence the upper atmospheric ionization. According to the first process, the electric moment associated with a thundercloud produces an electrostatic field in the E_1 layer. Due to the low pressure (hence long mean freepath) the electrons present in the E_1 region may acquire a high velocity under the influence of this field and thus increase ionization by collision. The second process by which thunderclouds may indirectly affect ionization is associated with the production of the "runaway electrons". Due to the presence of intense electric field inside the cloud the upper part of which is positively charged, any electron (of radioactive origin or one produced inside the cloud by local discharges) inside the cloud will shoot upward with high energy of the order of 10^9 e.v. (Schonland, 1932). A stream of such electrons might, after reaching the top of the cloud, move with tremendous speed if at this instant, a spark discharge takes place and destroys the upwardly directed strong field between the upper part of the cloud and the lower boundary of the E_1-layer. These runaway electrons, inspite of the influence of the earth's magnetic field, might have sufficient initial velocity so as to reach the E_1-layer and thereby to increase ionization.

Besides these two much discussed processes a third process has recently been suggested by Bailey (1937) and amplified by Healey (*A. W. A. Tech. Rev.* *3*, 215, 1938). In the two processes of C. T. R. Wilson, the influence of the steady electrostatic field of the thundercloud is evoked to explain the ionization increase. In the process of Bailey and Healey, the effect of the radiation field due to electric discharges in the thunderclouds is taken into account. Healey's calculations show that if the radiation field from a lightning flash has a value more than 5 V/m there must be notable increases in the ionization density of the E_1-region where the collisional frequency is less than 10^6. Observations of Munro and Huxley (1932) show that field strengths of 5 V/m at the E_1-region are not uncommon and that occasionally, values as high as 10 V/m may occur. The available evidence therefore suggests that the radiation field from lightning flashes besides producing the atmospherics may also cause marked changes in the ionization density of the E_1-region of the ionosphere.

S. P. G.

Colorimetric Determination of Sex Hormones

Œstrogenic hormones are characterised by their phenolic group in Ring I of the cyclopenteno phenanthrene skeleton. Their conversion into azo dyes suggests itself as a suitable analytical method to replace time-consuming and expensive animal tests.

Simple diazonium compounds such as diazotised p-nitraniline or sulphanilic acid usually couple to yield yellow, orange, or red dyes not advantageous for a colorimetric method.

From a number of intermediaries used in the manufacture of dyestuffs, and known to give exceedingly deep shades on coupling with naphthols, Marx and Sobotka (*J. Biol. Chem.* *124*, 693, 1938)

found that the best result was obtained with diazotised p-nitrobenzene azodimethoxy aniline ("K-salt"), the resulting dye hav ng the deepest colour, whereas estrone, estriol, and estradiol contain only one aromatic ring, equilenin and dihydroequilenin, found in horse urine, are endowed with five double bonds and may be considered as substituted β-naphthols. Accord ngly, equilenin and its dihydroderivative react much more readily with "K salt" than estrone or estradiol. The deep blue colour given by equilenin and its dihydroderivative lends itself to colorimetric determination of amounts even as low as 2 micrograms. On the other hand, estrone, estriol, and estradiol do not couple readily under similar conditions.

The specificity of the test makes it suitable for a study of the fluctuations of the relative share of equilenin in the total sex hormone concentration during the various periods of pregnancy in the mare.

The test indicates the complete absence from the urine of equilenin or dihdro equilenin in human pregnancy. Urine samples of 250 c.c. were hydrolysed with 40 c.c. of concentrated HCl and extracted with ether or chloroform. The solvent and volatile phenolic substances were then completely removed by steam distillation, the residue made up with alcohol to a given volume, and aliquot portions used for the colorimetric determination.

H. N. B.

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(6) Vitamin C and Toxins. Part I. The Effect of Vitamin C and other Reducing Substances and Diptheria and Tetanus Toxin *in vitro*. By Baidyanath Ghosh and B. C. Guha.

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(10) Strainless Monocyclic Rings. Part II. Synthesis of 3-Methyl-*cyclo*-hexane-1-carboxy-1-acetic Acid and Separation of its Isomers.—By Muhammad Qudrat-i-Khuda, Ashutosh Mukherji and Phanibhushan Banerji (in part).

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Research Work in India

Royal Institute of Science, Bombay (1937-38)

The work of the organic laboratory of the Royal Institute of Science, Bombay comprises two main

divisions; one involves a careful examination of the methods available for the synthesis of coumarins; the other relates to a study of the chemical activity of katio-enoid systems such as chalkones with particular reference to the synthesis of natural products related to chalkones.

Coumarins.—The condensation of methyl β-resorcylate and polyhydroxy phenolic ketones with ethyl acetoacetate in the presence of a new reagent *viz.*, aluminium chloride has readily afforded 4-methyl-5-hydroxy-coumarin derivatives of synthetical importance which are otherwise difficultly accessible; the other known condensing agents giving 4-methyl-7-hydroxy coumarin derivatives. Aluminium chloride has also been found to be a very efficient condensing agent in the case of simple phenols, particularly monohydric phenols.

In connection with the above work, a systematic study of the condensation of polyhydroxy phenyl-carboxylic esters and polyhydroxyphenyl-ketones with β-ketonic esters in the presence of sulphuric acid is under progress, and has resulted in the synthesis of a number of coumarin carboxylic esters and acetyl-coumarins.

In another investigation methyl β-resorcylate has been formylated by the modified Gattermann reaction developed in these laboratories, the formyl group entering the usually inaccessible γ-position giving methyl 2:4-dihydroxy-3-formyl-benzoate, which has provided a suitable intermediate for a convenient synthesis of γ-resorcylaldehyde and of the hitherto unknown 5 hydroxy coumarin. The application of the modified Gattermann reaction to polyhydroxy phenolic ketones has similarly led to formylation in the γ position, with the production of hydroxy-3-formyl-phenyl-ketones, a hitherto unknown class of compounds, the synthesis of which has opened up various possibilities for the synthesis of heterocyclic oxygen-ring compounds like coumarino-chomones, furochromones, etc., which are being explored. Methyl 2:4-dihdroxy-3-formyl-benzoate and the various hydroxy-formyl-phenyl-ketones obtained as above have been converted through the Knoevenagel reaction into interesting coumarin derivatives.

The formation of 5-hydroxy coumarins in the condensation of β-ketonic esters with phenolic ketones, etc., and the γ-substitution in the Gattermann reaction on phenolic esters and ketones, have both been satisfactorily explained on the basis of the stabilisation of one of the Kekulé forms of the benzene nucleus resulting from the formation of a chelate ring.

Flavones and Chalkones—Kostanecki's method for the synthesis of flavones involving the action of alcoholic alkali on *O*-acetoxychalkone dibromies broke down when applied to the production of natural hydroxy-flavones, benzylidenecoumaranones being obtained in place of the expected flavones. Attempts made in the interval to explain the dual nature of the reaction have not been successful. Careful examination of the reactivity of number of chalkones in this laboratory have shown that the presence of a *P*-alkoxygroup in the styryl nucleus of the chalkone leads to the intermediate formation of an ethoxy-compound by the action of alcohol on the chalkone dibromide and that this ethoxy-compound forms a benzylidenecoumaranone with alkali. By using acetone and alkali in place of alcohol and alkali, the flavone can be obtained without formation of a benzylidenecoumaranone. The flavone can also be synthesised from the hydroxychalkone dibromide, by heating above the melting-point, or by using alcoholic potassium cyanide. Chalkones of the pholoroglucinol series which give rise readily to benzylidenecoumaranones also give flavones with potassium cyanide and alcohol, or on being heated above the melting-point. Based on this work modified methods, have been devised for the synthesis of chrysin, apigenin and luteolin, and the synthesis of lotoflavin which is thought to be 5:7:2':4'-tetrahydroxyflavone is now in hand.

The synthesis of polyhydroxychalkones from their aldehydic and acetophenone components has been effected in a number of cases, and the corresponding naturally occurring hydroxyflavanones and hydroxychalkones have been synthesised in relatively simple ways. It has also been shown that benzylidenecoumaranones give a number of the reactions of chalkones and this will lead to the synthesis of a variety of new ring systems.

LETTERS TO THE EDITOR

[The Editor is not responsible for the views expressed in the Letters.]

On the Action of Minute Doses of Drugs

It is well known in medicine that extremely small amounts of different substances are capable of producing profound therapeutic or pathogenetic action on human system. Drugs and antigens in minute quantities are often used with great success in modern medical practice. Adrenaline in doses of 0.002 to 0.0001 c.c. is sometimes able to afford relief in acute paroxysms of asthma or to bring about a rise in blood pressure in cases of severe surgical shocks. Tubercle vaccine containing powdered tubercle culture to the extent of 0.0000001 to 0.000000001 gram is found to be a useful means of checking the progress and possibly of curing tuberculosis in human beings. Actions of substances like sal volatile in curing fainting fits when inhaled, and of poisons like hydrocyanic acid in causing death are further examples of definite effects brought about by exceedingly small quantities of substances.

These positive evidences make one feel inclined to investigate more fully the effect of minute quantities of drugs on the system, and to ascertain, if possible, the smallest quantities of different drugs necessary to bring about a clear pathogenetic or therapeutic action. Claims have been put forward in certain quarters, firstly, that drugs become more potent in their action as smaller quantities of them are used, and secondly, that even in infinitesimal doses (for example, in 1,000 to 1,000,000 dilutions) drugs are capable, when properly chosen, of relieving suffering and curing disease, there being apparently no minimum therapeutic limit established. This latter problem apparently involves an issue of great interest.

According to our physical concept, the number of atoms contained in one gram of silver

$$\frac{6.06\times10^{23}}{107.88}$$ where 6.06×10^{23} is Avogadro's number.

In the first dilution, obtained by triturating 0.01 gram of silver with 99 times its weight of sugar of milk, the number of atoms of silver

$$\frac{6.06\times10^{23}}{107.88\times10^{2}}.$$

In the second dilution, the number of atoms

$$\frac{6.06\times10^{23}}{107.88\times10^{4}}$$

In the tenth dilution, the number is diminished to

$$\frac{6.06\times10^{23}}{107.88\times10^{20}}=56 \text{ (approx).}$$

If the eleventh dilution is now made by mixing one part of tenth dilution with ninety-nine parts of alcohol, the chances are about even that there will not be a single atom of silver in the whole bottle. In the next dilution the chances of there being even a single atom of silver is reduced to about 1 in 200. Thus, one is justified in concluding that for all practical purposes there is not a single atom of silver present in twelfth and higher centisimal dilutions. The same is true of any other substance considered. Yet, claims of marvellous cures of diseases with 30th., 200th., 1,000th., and 1,000,000th., dilutions are frequently reported. It may be noted that the dose of tubercle culture in tubercular vaccine may be compared to the 4th. centisimal dilution of the homeopaths. Although a considerable portion of the evidence of cures cited are unsatisfactory and uncertain, the question at any rate is certainly worth investigating in a systematic, scientific manner.

Calcutta
25-7-38

B. N. Mitra

Note on Dr B. N. Mitra's paper.*

In his communication "On the Action of Minute Doses of Drugs," Dr Mitra has made certain very interesting observations and has drawn pointed attention to a subject of basic importance not only to pharmacology and chemotherapy but also to general physiology and enzyme chemistry. There is hardly any doubt that more attempt should be made to understand the complex phenomena underlying the physical and chemical basis of pharmacological action. Unless we know more of the kinetics of drug action, the process of penetration of drugs into the cell, the rate of

*By the courtesy of the editor I was shown the note by Dr B. N. Mitra, D.Sc., Ph.D.

fixation of drugs by the cells and the concentration-action relation it will not be possible to attempt any satisfactory explanation of the problems raised in the note of Dr Mitra.

With the development of physical chemistry and the newer conceptions about the structure and organization of the cell surface, there is evidence of increasing interest being focussed on the problem of the nature and quantitative a system that provides formal proof of the laws that it enunciates but the pharmacologist dealing with living cells cannot simplify his *living* material as he wishes. Life is only maintained over certain narrow ranges of chemical and physical conditions and any attempt at changing the variables to suit experimental conditions may result in death. Therefore the pharmacologist must remain content with intelligent guesses. Even in the most favourable cases where quantitative relations have been established for the action of drugs on cells, there probably remain dozens of unknown variables, and

TABLE

Minimum doses of hormones and vitamins that produce responses in intact animals

Drug.	Animal.	Effect measured.	Dose given (γ per Kg.).	Author.
Acetyl choline HCl.	Cat	Fall in B.P.	0.000,002	Hunt (1918).
Adrenaline HCl.	Cat	Vaso-dilatation of denervated limb	0.000,005	Dale and Richards (1918).
	Cat	Inhibition of intestine	0.000,7	Lim and Chen (1925)
	Cat	Rise in B.P.	0.07	Wilkie (1928).
	Dog	Rise in B.P.	0.01	Molinelli (1926).
	Rat	Inhibition of uterus	0.5	Kuans and Clark (1925).
	Man	Rise in pulse rate, etc.	0.025 (per min.)	Cori and Buchwald (1930).
Active principle of posterior lobe of pituitary (partly purified)	Cat	Rise in B.P.	0.05	Abel (1930).
Oestrin, crystalline	Rat	Production of oestrus	1·5	D'Amour and Gustavsen (1930).
Insulin, crystalline	Rabbit	Fall of blood-sugar	10	Abel (1926).
Thyroxin	Mouse	Rise in metabolism	200 per diem.	Gaddum and Hetherington (1932).
Vitamin A	Rat	Effect on growth	3 per diem. 0.02	Moore (1930).
Vitamin D	Rat	Effect on bones	0.02 per diem.	Coward (1928).

evaluation of drug action on biological tissues. The most important difficulty that stands in the way of a scientific and systematic enquiry however is the extreme complexity of all systems that contain living organisms and cells. Though we often apply the laws of physical chemistry in explaining the phenomena of drug action, it should not be forgotten that the simplest living cell constitutes a system far more complex than that usually investigated by the physical chemist. Quantitative pharmacology, although it may use the laws of physical chemistry, cannot really follow the methods of the physical chemist. The physical chemist can simplify his conditions and reduce the number of variables until he obtains there is usually a considerable range of possible alternative explanations.

Because of these difficulties inherent in the complex living systems, claims have often been advanced which cannot have any scientific basis, when judged from the known laws of physical chemistry. If it were possible to bring biological methods to the same degree of exactitude as obtainable in physics and chemistry, many of these claims of homeopaths of producing biological and clinical effects in the 100,000th dilution would long have been exploded. Because there is positive evidence that a very small dose of adrenaline or tubercle vaccine can produce significant and measurable

effects, it has been comparatively easy for the homeopath to stretch by analogy the limit of dilution to any extent. However, let us see whether by adopting the known laws of physical chemistry, we can offer a satisfactory explanation of how a biological response could be produced by such small doses of drugs as is reported in cases of adrenaline and acetylcholine. Clark[1] has given a very interesting table containing the minimum concentrations of certain powerful drugs *e.g.*, acetylcholine, adrenaline, pituitrine, oestrin, insulin, thyroxin, vitamin A and vitamin D, that have been proved with fair certainty to produce an effect in intact animals. The smallest values are those, given by Reid Hunt for acetylcholine (0.000,002 γ per kilo) and by Dale and Richards for adrenaline (0.000,005 γ per kilo). As far as the writer is aware, these two values represent the smallest quantities of drug that have been proved with certainty to produce an action on living tissues. In the case of smell, extraordinary figures for dilution have been reported and Newton Harvey[2] stated that fluorescence could be detected at a concentration of 1 part in 10^{9} dilution. These figures however have not been sufficiently well authenticated. Anyway, it will serve our purpose if we take the case of these two extreme figures of adrenaline and acetylcholine and calculate the probable concentration that they will reach at the cell surfaces. The doses of acetylcholine and adrenaline referred to above, were given intravenously and produced an immediate and transient action. These figures should therefore be calculated as the probable concentration produced in the blood stream, rather than as the dose per kilo. If it be assumed that the drug is mixed with half the volume of the blood, then the minimum effective concentration in these two cases is of the order of 1 in 10^{12}. This dilution of one part in 10^{12} contains, however, about 10^{8} molecules per *c.c.* and the actual dose administered, namely about 10^{-5} γ, contains about 10^{10} molecules. Parker[3] estimated the number of cells in the body of a man weighing 70 kilo, as 26×10^{12}. This corresponds to an average size of cell of 2700 cu. γ or about 3×10^{11} cells per kilo. If the molecular weight of adrenaline or acetylcholine be taken as approximately 200 (183.1 & 163 respectively), then 10^{-5} γ would provide 3×10^{12} molecules. Hence a dose of 0.000,005 γ per kilo would supply sufficient number of molecules to form a monomolecular layer on all the cells of the body. The fact that a dose of this magnitude produces a pharmacological response does not therefore involve any special physico chemical difficulty. Comparable figures have been obtained in certain cases with non living systems. For example, Bredig and V. Berneck[4] (1899) found that platinum solution in a concentration of 3×10^{-9} gm. platinum per *c.c.* caused a measurable decomposition of hydrogen peroxide, and Paal and Amberger[5] found the same with osmium solution at a concentration of 9×10^{-10} gm. per c.c.

It must be pointed out however that calculations of this nature can only provide very rough approximations, because, on the one hand, the active principles are probably selectively fixed by the tissues on which they act, and, on the other, they are fairly rapidly broken down by or excreted from the body. Nevertheless, the considerations outlined above regarding the smallest quantities of acetylcholine or adrenaline producing an effect on body tissues show that even in these concentrations, the number of molecules available would be enough to provide a monomolecular layer on the cell surfaces and that there is no necessity to assume special laws of physical chemistry to explain such observations. These dilutions however bear no relation to the homeopathic dilutions. Hahnemann claimed that drugs at the 30th potency produced reliable effects. His observations were limited entirely to clinical materials which are generally so variable that no definite conclusion can be drawn. It has been repeatedly shown that an estimate of cure based on symptomatology alone is never trustworthy. To draw the conclusion that a particular drug has cured dysentery by observing an improvement in diarrhoea, for example, is naturally hazardous. In comparatively recent times, Konig[6] has adduced some evidence to indicate that a drug may still retain its effectiveness in 25th 30th dilution, but his methods and conclusions are not above reproach to critical workers. A homeopathic potency means a dilution one hundred fold, and hence the 30th potency corresponds to a concentration of 1 part in 10^{60}. This works out at about one molecule in a sphere with a circumference equal to the orbit of Venus. Such results may be either believed or disbelieved, but their acceptance involves discarding the fundamental laws of chemistry and physics.

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2-9-38.

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On the Amount of Iodine present in Foodstuffs

Iodine that is required for our physiological well-being is generally obtained by the body from the different foods, drinking water and common salt consumed. But the quantities of iodine present in most of these materials are practically insignificant; and this factor often gives rise to much difficulty in its assaying from any of the foodstuffs. Recent researches[1] have definitely established that iodine is indispensable for the prevention and cure of endemic as well as exopthalmic goitre. Further the element being a constituent of thyroxine—the active part of thyroglobulin molecule present in thyroid gland, is also essential for proper growth and physiological activity of the body.[2] Accordingly, it seems to be of considerable importance to know the amount of iodine that is present in different foodstuffs usually consumed by the people of any locality. With this idea and for the fact that sea foods are generally rich in iodine, certain fishes, aquatic plants, and the different types of common salt available in the local market

have been analysed. The former two were decomposed by potassium dichromate-sulphuric acid mixture in presence of a trace of ceric sulphate. The iodate formed was converted to iodine by means of phosphorous acid (purified) and the resulting mixture was distilled from an all glass set made and fitted on the principle of Stevens.[3] The liberated iodine was again absorbed in normal caustic potash solution in a receiver made according to Trevorrow and Fashena.[4] The distillate was concentrated and the amount of iodine present was finally ascertained after the customary bromine oxidation process by titrating against 0.001 N. Thio. with proper precaution. For its presence in minute quantities blanks are often being conducted to test the purity of the reagents used, or, to know whether there is any outside contamination. The salts were being estimated by the alcoholic extraction method of Cheng and Wang[5] with due precaution as suggested by Harvey.[6] The following table gives the amount of iodine present in certain foodstuffs that are being assayed. The data on the salts are on dry basis.

TABLE.

Name of the substance.	Iodine (parts per billion).
Panphal (Trapa bispinosa)	506
Hingche (Enhydra Fluctuans)	407
Kalmi Shak (Ipomoea reptans)	1526
Shalook stem (Nymphaea alba)	176
Patal (Trichosanthes dioecia)	190
Begun (Solanum melongena)	610
Puin Shak (Bassela cardifolia)	133
Hilsa fish (Clupea Hisa)	784
Katla fish	1484
Chingree fish (Prawn variety)	1900
Ruhee fish (Labeo Rohita)	3100
Cow's milk (*a*)	265
" " (*b*)	313
Salt (country made)	832
" (kurkach)	800
" (foreign)	450
" (saindhab, rock salt)	346

As the amount of iodine (iodide) present in any ordinary salt would considerably depend on the nature of its storage, it would be proper to analyse any sample of this from a definite source. For this various samples of sea salt are being collected from the different agents through the kind permission of Collector of Customs, Calcutta, and the rock salt has been kindly supplied by the Administrative Officer, Salt Range Division, Central Excise and Salt, Northern India, Khewra. Regarding others it would be of much interest to know the difference in the iodine content of the foodstuffs from regions situated near and far away from seas. The work in all these directions is in progress.

We, in conclusion, wish to record our sincere thanks to Dr. P. C. Mohanti of the Science College, Calcutta University for a supply of a sample of ceric salt.

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9 9 38.

U. P. Basu
H. Goswami

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A Note on Grid Sampling

In field surveys, the sampling units or grids usually have definite spatial connexions. In a purely random field such connexions are absent, and the sampling variance (ignoring boundary conditions) conforms to the binomial distribution. In other cases, analysis of data collected in the course of certain recent crop surveys (again ignoring boundary conditions) shows a more generalized type of distribution, in which the variance is inversely proportional to a constant power of the size of the sampling unit. This result enables the field characteristics being defined with the help of two parameters.

The efficiency of a sampling programme depends on two factors, namely, the magnitude of the sampling error and the total cost or time necessary for the sampling work. The result given in the previous paragraph determines the sampling error. The second factor can be studied by constructing suitable cost functions which depend on the size of the sampling units as well a on their density. The efficiency of sampling can then be suitably defined in terms of the variance function and the cost function. Maximizing this expression in the usual way, it is finally possible to determine the most efficient sampling programme for a given expenditure for different types of field.

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Catalytic Reduction of Carbon Monoxide

Carbon monoxide reduced by hydrogen at atmospheric pressure in presence of nickel catalyst is known to yield only saturated hydro-carbons. An attempt to prepare unsaturated hydrocarbon has been successful by use of nickel-copper catalyst. Thus with a promoted nickel-copper catalyst reduced at 275°C, a gas mixture of the following composition has been obtained on carrying out the reaction at 248°C. CO_2, 0.3%; unsaturated hydro-carbon, 3.7% Carbon monoxide 23.3%; Hydrogen 71.0%; Methane 1.7%.

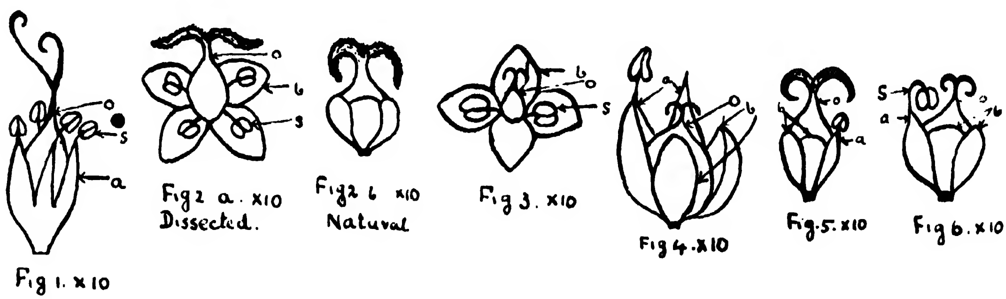
LETTERS TO THE EDITOR

The yield of unsaturated hydrocarbon decreases with an increase of the reaction temperature. It is to be noted however that copper catalyst alone is not known to catalyse the reduction of carbon monoxide at atmospheric pressure.

Chemical Laboratory, Dacca University. 23.8.38. K. M. Chakravarty.

On the Hermaphrodite Flowers of *MORUS INDICA* Linn

In course of selection work on the mulberry we came across certain "forms" of *Morus Indica* Linn which normally appear to produce hermaphrodite flowers. In the family Moraceae flowers are usually unisexual either monoecious or dioecious. Occasional occurrence of such hermaphrodite flowers has been noted by Eichler[1] and H. Walter[2] in *M. alba* and *M. nigra*. In view of the fact that this phenomenon has not been noticed in India up to now, we report the following observations, made during the course of our studies, which show how progressive reduction in the number of stamens has led to the production of unisexual flowers in the Moraceae.



Explanation: a—Perianth segment like that of ♂ flower, b—Perianth segment like that of ♀ flowers. O—ovary, S- stamen.

(Figures are arranged according to the reduction in the number of stamens in the ⚥ flowers.)

(1) 4 stamens with long filaments in the ⚥ flowers. Such flowers are found associated with ♀ flowers in the same inflorescence. (The specimen was collected from the Sericultural Research Station, Narayanpore Colony, Dum Dum, 24 Parganas). (Fig. 1).

(2) 4 stamens in the ⚥ flowers. Here the inflorescences contain only ⚥ flowers. From general appearance the flowers appear to be female but on dissection and careful examination 4 stamens with short filaments are found enclosed under the perianth segments. (The specimen was colected from the Berhampore Central Nursery, Murshidabad). (Fig. 2 *a* & *b*).

(3) 2 stamens with short filaments the ⚥ flowers. The inflorescence contains ♂ flowers (with 2 stamens and pistillode), ♀ flowers (with ovary and 1 ovule) and ⚥ flowers (with 2 stamens and ovary with 1 ovule). (The specimen was collected from the Mirganj Central Nursery, Rajshahi). (Fig. 3).

(4) 2 (?) stamens in the ⚥ flowers. These flowers are found to be associated with ♂ and ♀ flowers but only three such flowers were found after examination of several inflorescences. One perfect stamen was present and the another of the other probably had fallen down, only the base of the filament being found after dissection. The male flowers however contain 4 stamens and pistillodes and are found at the base of the inflorescences. (The specimen was collected from the Mirganj Central Nursery, Rajshahi). (Fig. 4).

(5) 1 stamen in the ⚥ flowers. These ⚥ flowers are found associated wit the ♀ flowers in the sam inflorescence. (The specimen was collected from the Bogra Sericultural Nursery, Bogra). (Fig. 5).

(6) 1 stamen in the ⚥ flowers. These flowers are

found associated with the ♀ flowers in the same inflorescence. In this plant the male inflorescence contains only ♂ flowers with 4 stamens and pistillode. (The specimen was collected from the Government Sericultural Farm, Vishnupur, Bankura). (Fig. 6).

The one point to be noted in this connection is the character of the perianth segments in the ⚥ flowers. In most cases, perianth segments subtending the stamens are like those of the ♂ flowers but in case of No. 2 & No. 3 perianth segments are like those of the female flowers. It is very likely the flowers are not mature and the segments have not developed properly. Probably it is for this reason that the stamens have not come out of the perianth segments.

I wish here to express my indebtedness to Mr S. C. Mitter, Director of Industries, Mr C. C. Ghosh, Deputy Director of Sericulture, Bengal and Dr S. P. Agharkar, Head of the Dept. of Botany, Calcutta University for their guidance, encouragement and criticisms in this investigation.

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24 Parganas.
30-8-38.

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Variation of the Amplification Factor of Thermionic Valves in a Magnetic Field

The effect of the magnetic field on the electrons in a thermionic valve has been utilized by various investigators[1,2] for the production of oscillations and rectification, but so far nothing has been said about the amplifying properties of a magnetic field valve. The increasing use of these valves has led to the urgency of finding out the effect of the magnetic field on the amplification factor. In the present communication a thermionic valve has been subjected to a homogeneous magnetic field and the performance of the valve has been studied.

A Helmholtz type of solenoid was used for the production of the homogeneous field. The characteristic curves of the valves were drawn at different magnetic fields and from these curves the amplification factors were computed. The variation of the amplification factor with the magnetic field was also studied by means of the modified Miller's bridge used previously by the author[3].

It was observed that the form of the valve characteristic curve is modified by the presence of the magnetic field. Weak magnetic fields, with certain plate and grid potentials on the valve, increased the amplification factor. After a certain critical field, for the above potentials, the amplification factor decreased continuously with the increase of the magnetic field. The critical field where the amplification factor is maximum is dependent on the plate and grid potentials. The amplification factor of a valve increased from a value of about 19 to 23 as the field was increased to 73.2 gauss and after this critical field it decreased continuously to a value of 18 for a field of 209.8 gauss.

The author has great pleasure in thanking Prof. P. Dutt and Dr S. S. Banerjee for the facilities for carrying out the work.

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The Indian Historical Congress

The second session of the Indian Historical Congress, which was held in the first week of October at Allahabad under the presidency of Prof. D. R. Bhandarkar, was a great success not only on account of the great richness of the social and intellectual feast it afforded to the historians assembled, but also owing to certain very important and far reaching resolutions passed at this session. The presidential address of Prof. Bhandarkar, himself one of the leading authorities on the Hindu epoch, and worthy son of the great pioneer of ancient Indian history, the late Sir R. G. Bhandarkar, was mainly confined to a refutation of the oft quoted charge that the ancient Hindus did not care for the art of history-writing, that they talked only in myths and legends. Apart from referring to the existence of the famous Chronicle of Kashmir, the *Rājataraṅgiṇī* the learned President quoted passages from many inscriptions to prove that the writers of these *had* access to authentic records of political events of bygone days. Much of these records, according to Dr Bhandarkar, was destroyed during the successive historical revolutions, but a fraction still remains preserved in the old collections of various States and old libraries.

Recent discoveries have shown that Indian history surpasses both in Time and Space that of any other country in the world, but about 150 years ago when, with the foundation of the Royal Asiatic Society of Bengal, the history of this ancient land began to excite the interest of European scholars settled in this country, the amount of extant knowledge was extremely meagre. There was good record of the events during the Muhammedan epoch, but all that were known about the Hindu epoch were certain dynastic lists preserved in the Puranas, and stray references scattered in a haphazard way in the vast Sanskrit literature. It was not at all clear, even to thinking minds, that the history of India extended several millennia before the time of Muhammedan conquest. The task of recovering ancient history must have appeared very formidable to the early pioneers; with the discovery of ancient inscriptions and discovery of ancient Sanskrit and Pali literature, savants were able to get some glimpse of the historical events going back to the sixth century before Christ. Curiously enough, though 1938 happens to be the centenary of the decipherment of Brāhmi inscriptions by James Prinsep, an event of

the greatest importance in the progress of our knowledge of ancient Indian History, the fact was not mentioned by any of the distinguished historians assembled at Allahabad. Ancient Indian History owes a good deal to the pioneering works of the European scholars like Prinsep, Senart, Bernouf, Maxmüller, Sylvain Levi and others. It was only somewhat late that the Indians began to interest themselves in the work. The early labours of Bhau Daji, Bhagwanlal Indraji, Raja Rajendralal Mitra and Mm. Haraprasad Sastri should not be forgotten at the present times nor should we fail to pay tribute to the searching intellect of Lokmanya Gangadhar Tilak, who unearthed from the Atharva Veda reference to Babylonian mythology, long before the discoveries at Mahenjo-Daro placed material evidence of such connection at our disposal.

But even 25 years ago, a well known book on the history of ancient India began with an account of Alexander's invasion of India. Some European historians were under the impression that Indian civilization started only after the Macedonian Greeks under Alexander made their much-talked-of inroads into India. Thanks to the discovery of Indus Valley Civilization in 1924 by the late R. D. Banerji, it is now possible to date Indian history to as hoary an antiquity as that of Egypt or of the Near East. The inscriptions and seals which have been discovered, however, await the genius of a James Prinsep before they can be made to yield their secrets. It is also a matter of extreme regret that the work so auspiciously begun by the Indian Archaeological Department had to be suspended owing to alleged dearth of funds, though the extensive survey by the late lamented N. G. Majumdar, has revealed a number of sites quite as promising as those of Mahenjo-Daro and Harappa in Sind and the Panjab, and even as far south as Gujrat. Another promising attack on this period of Indian history has been made by Rai Durgaprasad of Benares who by his searching analysis of signs on punch-marked coins has been able to demonstrate that these were minted by the Mauryan and pre-Mauryan imperial dynasties and by showing their analogy to many of the symbols used in the Mahenjo-Daro seals has shown that the Mahenjo-Daro tradition persisted even after the Aryan conquest; he has thus opened a promising way for penetrating into this dark period of Indian history (300 B.C.—2600 B.C.) echoes of which are preserved in the older Sanskrit literature.

A mere glance at the names of various sections and at the papers which have been read at the Historical Congress shows the immensity of the task before the Indian historian. Within the last 20 years, Indian scholars have risen to the occasion and made substantial contributions to almost all the epochs in Indian history beginning with the Buddhist times. In this labour, not only professed historians but also scholars of Sanskrit, Pali and even Indian scientists (chemists, astronomers, and medical men) have collaborated. But unfortunately there has been no synthetic presentation of the great panorama of Indian history. The average reader will much welcome the compilation of such a volume, as he has neither the time nor the leisure to go through the learned original works and treatises by the specialists. We, therefore, very heartily welcome the resolution moved at the Conference by the doyen of south Indian History, Dr Krishnaswamy Iyenger, that a committee be appointed consisting of a number of ancient Indian historians, with powers to co-opt, to examine the *feasibility* of preparing a scientific and comprehensive history of India with instructions to report at the next session of the Congress. The resolution provoked a good amount of discussion, some eminent historians like Dr Ishwari Prasad, objecting to the term '*feasibility*' and holding that there could be no point in debating about the feasibility of the project because this had already been demonstrated. The materials were already there and they had only to organize a powerful body of experts to carry out the objective. The discussion, however, showed a great divergence of opinion and ultimately the resolution as originally worded was passed.

Much as we welcome the motive underlying the above resolution, we consider that it is not possible for a body of experts to compile a synthetic history of India. All that they can do is to present us with a collection of chronicles dealing with the various epochs in all their aspects. But synthetic history can only be the product of a single original mind like that of Von Ranke, Mommsen, or a Maspero. There is great need for such a history

inasmuch as history is a subject, the teaching of which cannot be avoided; but as they are at present reported to the younger mind, they tell us a rather very disheartening story about the past of India. In fact, it is nothing but a collection of stories of murders, assassinations, large-scale famines, foreign invasions and large-scale destructions of cities, kingdoms and civilizations. Sometimes it sounds, as Voltaire remarked, as if we were listening to a never-ending story of highway robbery. But certainly as the Hon'ble Mr Sampurnanand, Minister of Education for U. P., remarked in opening the Congress, the actual history could not have been so black, as otherwise the Indian Nation would not have survived and most of the monuments and ancient literature would have disappeared without leaving any trace.

This original stamp on Indian history, as we read in college and school text books, was given by the early compilers and it is a misfortune that subsequent authors are like the proverbial *Gaddalika* following the old groove. One rarely comes across any critical analysis of the great mass-movements, or the economic causes leading to the great political events. A school book on Indian history, even while talking of the British period, scarcely gives any idea of the economic revolution which led to the disappearance of Indian arts and crafts during the fifties of the last century, leading to the present day large scale pauperization of the Indian masses. Neither does it deal in a very intelligent way with the current nationalistic and industrial movements nor discusses why India has not shared in the general world prosperity. The text-books are often crowded with useless illustrations which invoke no feelings in the Indian mind. Even while dealing with the Muhammedan history it is rare to come across any intelligent account of the great cultural contribution of Islam to India. In fact, the events are presented in such a way that communal bitterness is not only excited but accentuated, whereas the efforts of the great Muhammedan rulers at evolving a suitable system of government and promoting national life centering entirely round Indian interest are completely ignored.

We would very much welcome a history of India written from a new point of view and with a proper perspective, which will enable us to follow in an intelligent way the past historical events and enable us to grasp clearly the factors which were responsible for the successes and failures of the great human and political movements on this continent. History, as Croce said, ought to be written only by philosophers and philosophy by historians, as less competent men generally lose sight of the essential points for the detail. They mistake the tree for the forest. Of course even if such philosophers can be found, we cannot eliminate the personal factor. As in Europe, some may interpret history as the Interpretation of Divine Will, while others may see in it nothing but a succession of chance events which nobody can control. There may be, besides geographical interpretations, economic interpretations, as well as a racial interpretation. Europe passed through such phases of history-writing which had their great repercussions on politics. The economic interpretation of history started by Karl Marx led to the great socialist movements and culminated in the establishment of the great Soviet Republics. The racial interpretation started by Count Gobineau and carried on by Madison Grant and Houston Chamberlain led to the Nazi movement in Germany with its great influence on contemporary history.

No Indian history has yet been written from any such unitary standpoints. As a matter of fact, the art of history writing in India is still very crude and medieval. What is wanted for the future is a history which will pay more attention to the basic qualities of the great social and political movements, the causes of their success and failure; and thus enable the political philosopher to evolve a new Philosophy of Life and Action, involving society, politics, and private life to which every young Indian, irrespective of his province, caste or religion, can offer instinctive homage.

A Short History of Thermodynamics

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Henri Bergson in analysing the causes of laughter came to the conclusion that one laughs only when an incident or an object indicates human frailties. A man stumbles and hurts himself, and we laugh over it, not because we are cruel but because of his inability to overcome an obstacle. As human beings our first interest is in the man himself. The less sophisticated we are the more interested are we in the man, his activities and achievements. Interest in abstract truths comes later in life as we grow older and perhaps wiser. A Bengali poet sang centuries ago " Man is the supreme fact and there is nothing higher."

Students entering college life are young and unsophisticated and an interest in science must be created in them not only through scientific facts but also through a vivid description of the lives of the great scientists, their human greatness and weakness, their failures and successes. A proper narration of the age and the surroundings they live in and the facilities at their disposal are no less important for an adequate apprisal of the importance of their contributions towards the advancement of human knowledge.

To illustrate the point, let us take the history of the development of thermodynamics. Laws of thermodynamics are fundamental laws *i.e.*, they are not derived from some other laws, but are the shortest possible generalized statements of the results of our accumulated observations and experiences. They can be mathematically stated but not derived, and their validity can be proved only by experiments. Observations and experiences have been going on since the dawn of human intelligence and have been at times recorded as isolated facts. The underlying truth in all of them did not reveal itself all in a flash: It required master-mind to discover the principles pervading all of them. At last the First Law of Thermodynamics was clearly and unambiguously defined by Helmholtz in 1847. The Second Law preceded the First, and the Third Law was really discoveries third in order of sequence. These laws, dealing not with any particular material objects but with matter in general and being independent of the time-factor, required a long time for full clarification of their true implications and hence discoverers and expounders of the laws can claim almost equal credit. The following names are the most important in the history of thermodynamics.

Benjamin Thompson Count Rumford	(1753-1814)
Sir Humphry Davy	(1778-1829)
J. P. Joule	(1818-1889)
J. R. Mayer	(1814-1878)
W. Thomson (Lord Kelvin) ..	(1824-1907)
G. H. Hess	(1802-1850)
H. L. F. Von Helmholtz	(1821-1894)
Sadi N. L. Carnot	(1796-1832)
B. E. Clapeyron	(1799-1864)
R. J. E. Clausius	(1828-1888)
J. W. Gibbs	(1839-1903)
J. H. Vant Hoff	(1852-1911)
H. L. Le Chatlier	
W. Nernst	(1864-)
M. Planck	(1858)

The First Law

The fact that all friction produces heat was known for a long time; but the first person to pronounce it in a scientifically accurate manner is Count Rumford. A teacher, a scientist, a soldier, a philanthropist, that is a formidable array of titles which faithfully picture Benjamin Thompson, the

Yankee teacher, who became a Count. He founded the Royal Institution of London, which stands as a perpetual gift to science and the world. Benjamin Thompson was born in Woburn, Massachusetts, in 1753. His father died when he was only a year and a half old, and shortly after, his mother married again and young Benjamin lived with his step father. He had almost no formal schooling beyond learning the three R's and had to get himself apprenticed to a merchant for a living. Thenceforward he was self-taught except attending lectures, in 1771, on experimental physics at Harvard College, to which he walked every day from his home in Woburn, a distance of twenty miles. In the following years he worked as a teacher in Rumford, afterwards called Concord, where the eminent philosopher and assayist Emerson later lived. When his fame as a teacher spread he married a prominent young lady of Rumford who, having wealth and social position, helped her husband to achieve some of his other ambitions. The teaching profession, therefore, lost a valuable member. The American War of Independence took place at this time. Rebellion and Aristocracy do not well harmonize and Benjamin Thompson who sided with the British had to leave for England. But before he left, he was appointed a Major of a regiment and showed his military skill. In 1778 while a refugee in England, we find him deeply interested in the improvement of fire-arms, the testing of explosives and inventing a new code of marine signals. His notable works in these directions led to his election as a Fellow of the Royal Society in 1779. A teacher-scientist with military leanings, Lieutenant Colonel Benjamin Thompson, left England in 1783 for a continental tour in the course of which he came in contact with the Elector of Bavaria who invited him to become Major-General of Cavalry and Privy Councillor of the State of Bavaria with a palatial residence in Munich to live in. The King of England in releasing Colonel Thompson from his own service made him a knight with full honours. As a military and civil servant of the State, he reorganized the Bavarian army, immensely improved the condition of the industrial classes throughout the country by providing them with work and instructing them in the practice of domestic economy, and he did much to suppress mendicancy. The multitude of beggars in Bavaria had long been a public nuisance and a danger. In one day he caused no fewer than 2600 of these outcastes and depredators in Munich and its suburbs alone to be arrested by military patrols and transferred by them to an industrial establishment which he had already prepared for their shelter. In this institution they were both housed and fed and they not only supported themselves by their labours but also earned a surplus for the benefit of the State revenues. The principle on which their treatment proceeded is stated by him in the following memorable words:

"To make vicious and abandoned people happy, it has been supposed necessary first to make them virtuous. But why not reverse this order? Why not make them first happy and then virtuous?

Of course, the people of Bavaria were grateful and when the Elector became Vicar of the Holy Roman Empire he made Benjamin Thompson a Count who took his new name from the town of his youth, and became Count Rumford (1791).

In 1795 Count Rumford returned to England where reports of his work and accomplishments had preceded him, for he was now a popular scientist. While in London he became known as the first man to advocate home economics and dietetics.

In 1798 his outstanding work was presented to the Royal Society and published in his shortest manuscript (20 pages) under the caption "An Enquiry Concerning the Sources of Heat which is excited by Friction." Up to this time there had been a controversy on "the existence or non-existence of igneous fluid." There was a firm belief in a substance called "Caloric" which was defined as a fluid heat which flows from a hotter to a colder body. Count Rumford very conclusively disproved this theory as he worked on the boring of cannons for the Bavarian army. He noticed during the boring work that the metal turnings were hot enough to heat water to boiling. Then through a series of very interesting experiments, which individually excluded different variables, he concluded:

"It is hardly necessary to add that anything which any insulated body, or system of bodies, can continue to furnish without limitation, cannot possibly be a material substance; and it appears to me to be extremely difficult, if not quite impossible,

to form any distinct idea of anything capable of being excited and communicated in the manner the heat was excited and communicated in these experiments, except it be *motion*."

Thus was laid the foundation of the convertibility of one form of energy into another, a partial exposition of the First Law of Thermodynamics.

In 1799 he, in conjunction with Sir Joseph Banks, projected the establishment of the Royal Institution. It received its Charter of Incorporation on January 12, 1800, and Count Rumford became its first journalist, and himself selected Sir Humphry Davy as scientific lecturer there. He was the founder and the first recipient of the Rumford Medal of the Royal Society. He was also the founder of the Rumford Medal of the American Academy of Arts and Sciences and of the Rumford Professorship in Harvard University.

In 1805 he went to the Continent again. His first wife, his senior by 14 years, died in 1792. Now a widower for thirteen years, he married the wealthy widow of Lavoisier. This marriage was not a happy one, the widow of the discoverer of the Law of Conservation of Mass could not pull on well with the partial founder of the First Law of Conservation of Energy, so they separated. Count Rumford retired to Auteuil, France. Here he lived a happy and restful life with his flower gardens and books until the year 1814 when he died.

Though born of humble Yankee parentage, Thompson had all the instincts of an intellectual aristocrat. He was a natural leader, but never too removed to see the benefits that his money, his knowledge of science, and his leadership could give to humanity.

The lives of the other founders of the First Law are not as romantic or eventful as that of Count Rumford.

The work of Rumford was further extended by his nominee Humphry Davy in the Royal Institution. The name of Sir Humphry Davy (1778-1829) is familiar to all with any knowledge of chemistry. He made many discoveries but the greatest of them all was his discovery of Michael Faraday. Born of modest parentage, he was early in life, because of his father's untimely death, compelled to take charge of the family. By dint of indomitable courage and energy he rose to the highest eminence in the scientific world. He had all the gifts of a popular lecturer on scientific subjects. With his laughing gas, newly discovered alkali metals, safety lamp, etc., his lectures used to draw the biggest audience including members of the fashionable London society. So he was one of those who contributed considerably towards the popularization of scientific knowledge at the parting of the 18th century and the 19th in England. At the height of his fame he married a wealthy society lady, a relation of Sir Walter Scott. Young Michael Faraday, then a book-binder's apprentice, was encouraged in his scientific studies by the eminent Sir Humphry Davy and was later appointed as his assistant in the Royal Institution. Faraday is one of the best scientific experimenters, living and dead. In his experiments he could " see " the invisible, as he used to say that he could see the lines of force round a magnet. In spite of his very modest mathematical training he drew conclusions which baffled Maxwell. He had wonderful power of intuition and was truly a " Seer "in science. He had a saintly character and was the most lovable of all the scientists. Under the influence of his aristocratic wife Davy quite often humiliated Faraday and grew jealous of him as the fame of the latter spread far beyond insular England. The great Davy thus unwittingly exhibited his feet of clay. We have strayed away from our point but who can avoid paying homage to Faraday in dealing with the history of sciences?

" In 1799, Davy showed that when two pieces of ice were rubbed together water is produced. It was admitted by all that water contained a larger amount of caloric fluid than ice. Now supporters of the caloric theory asserted that heat is generated in friction because the substance produced by friction has less capacity for heat than the original substance. But the substance produced in Davy's experiment (water) contains more heat than ice, hence the caloric theory became untenable. Davy's experiment proved the greatest stumbling block for the caloric theory.

" But the valuable work of Rumford and Davy was soon forgotten and it was only about forty years later that the First Law of Thermodynamics

gained general publicity through the researches of Joule in England, Mayer and Helmholtz in Germany, and Colding in Denmark." (Saha and Srivastava).

Julius Robert Mayer (1814-1878) has been claimed by many, specially by his German colleagues, as one of the discoverers of the First Law, but his claim to this honour has been shown to be baseless by Lord Kelvin, P. G. Tait and G. G. Stokes. According to them, Mayer entirely ignored the grand fundamental principle laid down by Sadi Carnot—that nothing can be concluded as to the relation between heat and work from an experiment in which the working substance is left at the end of the operation in a different physical state from that in which it was at the commencement. Mayer has also been called the discoverer of the theory that heat consists in (the energy of) motion, but in the teeth of this statement we have Mayer's own words:—" We might much rather assume the contrary that in order to become heat, motion must cease to be motion." From all these controversies it seems that Mayer had a somewhat vague notion about the convertibility of heat into mechanical energy but it is certain that the true nature of the relation did not reveal itself to him. His experiments for the determination of the relation were indirect and that is why he missed the real significance. This controversy reminds one of a still bitter academic quarrel between the compatriots of Sir Isaac Newton and of the philosopher Leibnitz regarding their claim for the priority of the discovery of calculus long after both these great men were dead.

Mayer focussed the attention of the sciet world in this direction by reviving the problem but failed to make accurate formulation of his ideas, and it was left to J. P. Joule (1818-1889) to carry out very accurate measurements establishing the relation between heat and mechanical work. Joule was another self-taught British scientist. His most important scientific contributions are (*i*) the determination of mechanical equivalent of heat and (*ii*) the energy-changes during the expansion of gas, better known as Joule-Thomson Effect. The first confirmed the ideas of Rumford and Davy, and the second refuted the contention of Gay Lussac that, temperature remaining constant, the internal energy of a gas is independent of volume. Joule read his paper on " The Calorific Effects of Magneto Electricity and the Mechanical Value of Heat " at the British Association Meeting at Cork in 1843. In 1847, Thomson (afterwards Lord Kelvin) first met Joule at the Oxford Meeting of the British Association. A fortnight later they again met in Switzerland and together measured the rise of the temperature of water in a mountain torrent due to its fall. Joule's views on the nature of heat greatly influenced Thomson's mind with the result that in 1848 Thomson proposed his absolute scale of temperature which is independent of the properties of any particular thermostatic substance, and in 1851 he presented to the Royal Society of Edinburgh a paper on the dynamical theory of heat which reconciled the work of Sadi Carnot with the conclusions of Count Rumford, Sir Humphry Davy, J. R. Mayer, and J. P. Joule and placed the dynamical theory of heat and the fundamental principle of the conservation of energy in a position to command universal acceptance. It was in this paper that the principle of dissipation of energy briefly summarized in the Second Law of Thermodynamics was first stated.

The forms of energy dealt with in the generalizations mentioned above were chiefly thermal and mechanical and it was left to Hermann Ludwig Ferdinand von Helmholtz (1821-1894) to give the first law its final shape embracing all forms of energy. As the name implies Helmholtz was a German and a full-fledged university professor. It is an interesting historical fact that in England culture of both arts and sciences grew outside the universities up to the middle of the 19th century and in some cases even later. In Germany, on the other hand, with her centuries-old network of universities, culture even to this day, originates in and spreads from the universities.

Helmholtz was born at Potsdam, near Berlin. His father was a teacher of philosophy and philology in the Gymnasium, while his mother was a Hanoverian lady, a lineal descendant of the great Quaker William Penn—the founder of the State of Pennsylvania in U. S. A. Delicate in early life, Helmholtz became by habit a student. He showed

mathematical powers but these were not fostered by thorough training mathematicians usually receive, and in after years his attention was directed to higher mathematics by force of circumstances. As his parents were poor, and could not afford to allow him to follow a purely scientific career, he became a surgeon of the Prussian army. In 1842 he wrote a thesis in which he announced the discovery of the nerve cells in ganglia. This was his first work, and from 1842 to 1894 scarcely a year passed without several important, and in some cases epoch-making, papers on scientific subjects from his pen. He lived in Berlin from 1842 to 1849, when he became professor of physiology in Konigsberg; then he occupied the chair of physiology at Bonn, from there he moved to Heidelberg. Finally in 1871 he was appointed professor of physics in Berlin. In this post with which was coupled in 1887 the directorship of the Physico-technical Institute at Charlottenburg, he remained till his death in 1894.

Helmholtz was a versatile genius and in some respects may be compared with Leonardo da Vinci in the wide range of his interests and contributions. His researches in physiological optics and acoustics, the theory of colours, and sensations of tone, were epoch-making discoveries and inventions opening out new worlds to the students of medicine. For the later years of his life his labours may be summed up under the following heads: (*i*) on the conservation of energy; (*ii*) on hydro-dynamics; (*iii*) on electro-dynamics and theories of electricity, (*iv*) on meteorological physics; (*v*) on optics and (*vi*) on the abstract principles of dynamics. In all these fields his contributions were of great importance. In 1871 he announced that the velocity of the propagation of electromagnetic induction was about 314,000 metres per second. Faraday had shown that the passage of electrical action involved time, and he also asserted that electrical phenomena are brought about by changes in intervening non-conductors or dielectric substances. This led Clerk Maxwell to frame his theory of electro-dynamics, in which electrical impulses were assumed to be transmitted through the ether by waves. G. F. Fitzgerald was the first to attempt to measure the length of electrical waves. Helmholtz put the problem into the hands of his favourite pupil, Heinrich Hertz, and the latter finally gave an experimental demonstration of electro-magnetic waves, the "Hertzian Waves". The life of Helmholtz was uneventful in the usual sense. He was a man of simple but refined tastes, of noble carriage and somewhat of austere manner. His life, from first to last, was one of devotion to science, and he must be ranked, on intellectual grounds, as one of the foremost men of the 19th century.

As already mentioned, it was Helmholtz who for the first time in 1847 in his famous paper "Über die Erhaltung der Kraft" brought together all forms of energy under the Law of Conservation. Curiously enough to denote energy he used the word "Kraft", which means force. He cited all kinds of energy forms as were then known and showed their quantitative relations, and asserted that any kind of energy can be converted into any other possible variety and thus the total can neither increase nor decrease. This all-comprehensive idea of Helmholtz seemed so revolutionary to the scientific world of the time that his paper mentioned above was refused publication by the editors of Poggendorf's *Annalen der Physik* to which it was sent.

Later works on the First Law of Thermodynamics were either refinements of experimental data or its application to all possible natural phenomena.

The Second Law

The Second Law of Thermodynamics is of more intangible and elusive character for proper comprehension than the First Law. But its origin in the mind and method of Sadi Carnot dates earlier than the first establishment of the First Law. It is a matter of wonder how great minds can derive conclusions with quite insufficient data taking big jumps in their imagination over unfathomable chasms. Their process of reasoning is quite often not palpably logical from the current knowledge of the time. It requires equally great minds to construct the bridges for ordinary students to follow in their foot-tracks. Sadi Carnot's work was rendered understandable by Lord Kelvin just as Gibbs' work was so rendered by Ostwald later.

A SHORT HISTORY OF THERMODYNAMICS

Sadi Nicolas Leonhard Carnot (1796-1832) comes of a family well known in France for the last 150 years. His father, a military man and an engineer of repute, had to take active part in the French Revolution; as a member of the Committee he signed its decrees and was thus at least technically responsible for the acts of the Reign of Terror. He was elected one of the five Directors in November, 1795. Sadi Carnot's younger brother L. H. Carnot was a litterateur and a student of philosophy but later took to politics and was elected Senator for life. M. F. S. Carnot, the son of this younger brother was the fourth president of the third French Republic. All the other Carnots, greater than our hero in their own lands and in their own times, are now forgotten, but to the greater world Sadi Nicolas Leonhard Carnot has become immortal.

He was educated in the École Polytechnique and in 1874 at the age of eighteen got a commission in the Engineers with prospect of rapid advancement in his profession. But Waterloo and Restoration led to a second and final proscription of his father and, though not himself cashiered, Sadi was purposely told off for the merest drudgeries of his service. Disgusted with an employment which afforded him neither leisure for original work nor opportunities for acquiring scientific instruction he presented himself for examination for admission to the staff corps (etat major) and obtained a lieutenancy. He then devoted himself with astonishing ardour to mathematics, chemistry, natural history, technology, and even political economy. He was an enthusiast in music and other fine arts. He became Captain in the Engineers in 1827, but left the service altogether in the following year. His naturally feeble constitution further weakened by excessive study broke down finally in 1832. An attack of scarlatina led to brain fever, and he had scarcely recovered when he fell a victim to cholera of which he died in Paris on the 24th of August, 1832, at the early age of thirty six. The only work he published was that on his "Cycle" (1824). This contains but a fragment of his scientific discoveries, but it is sufficient to put him in the foremost rank, though its full value was not recognized until pointed out by Lord Kelvin in 1848 and 1849. Fortunately his manuscripts had been preserved, and extracts were appended to a reprint of his published paper by his brother L. H. Carnot in 1878. These show that he had not only realized for himself the true nature of heat, but had noted down for trial many of the best modern methods of finding its mechanical equivalent, such as those of J. P. Joule with the perforated piston and with the friction of water and mercury. Joule-Thomson's porous plug experiment is also suggested.

In the history of sciences it is quite often found that art precedes science. Conversion of heat into work was known and applied long before the true nature of either was realized. The steam-engine, a machine for the conversion of heat into mechanical work in which the working substance is water and water-vapour, has a long and chequered history dating back from 130 B. C. which is briefly as follows: -

(*i*)	Hero's apparatus (Alexandria, 130 B. C.)	
(*ii*)	Battista della Porta	(1601)
(*iii*)	Edward Somerset, Marquis of Worcester	(1663)
(*iv*)	Thomas Savery	(1698)
(*v*)	Denis Papin	(1705)
(*vi*)	Thomas Newcomen	(1705)
(*vii*)	James Watt	(1763)

In Watt's days it was found that only 5% of the heat could be converted into work and the rest of it was rejected as heat unutilizable under the circumstances. The question arises whether the waste is unavoidable, whether it was due to the faulty construction of the contrivance (the steam-engine) for conversion; even at the present time with the best type of steam-engines the efficiency of conversion does not exceed 18%. Carnot devoted himself at the early age of 28 to the solution of this problem and proved that this low efficiency is inherent in the nature of the problem of conversion of heat to work. He proved that the efficiency of a heat-engine is a function of the temperature of the source of heat and that of the surroundings.

Novelties (for these times) of Carnot's proof consisted in the following:—

(*i*) Introduction of a cyclic process, the working substance being brought back to its original condition with the same energy-content.

(*ii*) No Particular working substance was assumed.

(*iii*) An ideal engine with no loss due to mechanical defects.

(*iv*) Complete reversibility infinitely slow process—an idealized hypothetical working condition.

(*v*) Isothermal and adiabatic expansion and contraction; calculations of work and heat involved in these processes.

(*vi*) Tacit assumptions of conservation of energy and fixed relation between heat and work.

With the help of his ideal engine working in a cycle under reversible conditions Carnot calculated the theoretical maximum efficiency of conversion of heat into work under given values of temperatures; he showed that all reversible engines will show the same efficiency and no other engine any higher than this. Thus was laid unknowingly by Carnot the foundation of the Second Law of Thermodynamics. Carnot was ignorant of the true nature of heat at the time (1824) when he published his theorem of efficiency and followed the old caloric theory in his speculations but came to the right conclusions. It was Clapeyron who showed that Carnot's arguments and results remained intact when the kinetic theory of heat was introduced.

Importance of Carnot's theorem was not recognized at the time of its publication and it required a genius like that of Lord Kelvin to discern, explain, and proclaim it to the scientific world. The importance of temperature developed in this theorem in determining the efficiency of the conversion led Clausius to enunciate the second law in the following form. "Heat cannot of itself pass from a colder to a hotter body."

Rudolf Julius Emmanuel Clausius, (1828-1888) like most German professors was of migratory nature. It is a peculiarity of the German students that many of them move from university to university before they settle down in any one for the research work for the doctorate. Professors too offer their services to the highest bidder and change their allegiance accordingly. Clausius occupied the professorial chair in physics at Zürich, Würzburg, and Bonn. He was more a mathematician than an experimenter, his most important work being in molecular physics. The kinetic theory of gases owes much to his labours, Clerk Maxwell calling him its principal founder. It was he who raised it, on the dynamical theory of heat, to the level of a theory and he carried out many numerical determinations in connection with it, *e.g.*, of the mean-free-path of a molecule. By his restatement of Carnot's principle he put the theory of heat on a truer and a sounder basis and he deserves the credit of having made thermodynamics a science. He enunciated the second law in a paper contributed to the Berlin Academy in 1850 in the well known form, "Heat cannot of itself pass from a colder to a hotter body." When confronted with the statement that there may be parts of the universe where heat may flow from a colder to a hotter body, Clausius declared—"Mein Satz gilt für eine Welt wie sie ist, und nicht für eine erdachte Welt." (My law holds good for the world as it is and not for an imaginary world). The declaration of Clausius may be made in the defence of all fundamental laws which are based on actual experience and observation. If only any real contrary phenomenon be observed in nature the fundamental law concerned breaks down and not otherwise, simply on the ground of any imaginary contradictory happening.

Thus were laid the foundations of the First and Second Laws of Thermodynamics which were quickly followed by the explanation of their implications and applications to all kinds of natural phenomena. A host of scientists devoted themselves earnestly in this work and were rewarded with brilliant results. It is not possible in this short article to name them all in order of sequence and importance and we shall satisfy ourselves with a short description of the life and work of one of the brightest luminaries in this galaxy of stars—Josiah Willard Gibbs (1839-1903).

America in the early days of Gibbs did not loom large in the scientific world. The sum total

of her contributions to pure science was meagre both in quality and quantity. The atmosphere for research was neither congenial nor encouraging, and this fact, therefore, adds more to his credit. Interchange of ideas, battle of wits, helpful criticism and suggestions all go to develop the latent powers in a man whether he be a scientist, an artist, a literateur, or a philosopher. All these were comparatively lacking in the surroundings of Gibbs working as a professor in a provincial town in the then academically undeveloped America.

Josiah Willard Gibbs' father, bearing the same name, was professor of sacred literature in the Yale Divinity School. The son, the scientist, graduated from Yale College at the age of 19 in 1858. For the next five years he studied there, got the doctorate degree in 1863 and was appointed a tutor to teach Latin and then natural philosophy. In 1866 he with his sister went to Europe, visiting Paris, Berlin, and Heidelberg one after the other and attending lectures by Magnus, Kirchoff and Helmholtz. He returned to New Haven, the seat of Yale University and two years later in 1871 was appointed professor of Mathematical Physics in Yale College, a position which he held until the time of his death.

He published his first two papers (*i*) Graphical Methods in the Thermodynamics of Fluids and (*ii*) A Method of Geometrical Representation of the Thermodynamic Properties of Substances by Means of Surfaces in 1873 in the *Transactions of the Connecticut Academy*. These two were followed in 1876 and 1878 by his most important work, "On the Equilibrium of Heterogeneous Substances," in two parts. The last is considered generally, and probably rightly, his most outstanding contribution to physical science and is unquestionably among the greatest and most enduring monuments of the wonderful scientific activity of the nineteenth century.

Gibbs was inclined to the use of geometrical illustrations which he employed as symbols and aids to the imagination, rather than the mechanical models which have served so many great investigators. Mechanical models do not in all respects agree with the phenomena they represent, and Gibbs' extremely logical mind was dissatisfied with such discrepancies and he, therefore, had recourse to the geometrical representation of his equations. Before his time, in thermodynamic treatment, only the volume-pressure diagram was used, and it was he who for the first time used entropy and temperature as coordinates; this method has found very important practical applications in the study of the steam-engine. Next he applied with greater emphasis the volume-entropy diagram which properties are proportional to the quantity of the substance while pressure and temperature are not. From this he went over to diagrams in three dimensions (volume, entropy and energy) to develop the properties of the resulting surface, the geometrical conditions of equilibrium, the criteria for its stability or instability, the conditions for co-existent states, and for the critical state. The exceptional importance and beauty of this work by hitherto unknown writer was immediately recognized by Maxwell, who, in the last years of his life, spent considerable time in carefully constructing, with his own hands, a model of this surface, a cast of which, very shortly before his death, he sent to professor Gibbs.

His third paper, that on the equilibrium of heterogenous substances he begins with the following well-known statement of Clausius: "Die Energie der Welt ist constant. Die Entropie der Welt strebt einem maximum zu." (The energy of the World is constant. The entropy of the world is tending towards a maximum). In this paper the most important step is taken of introducing as variables in the fundamental differential equation, the masses of the constituents of the heterogeneous body. It is impossible to narrate the importance of this work here and it may suffice the purpose to state that Le Chatelier compared it with the Law of Conservation of Mass enunciated by Lavoisier. There is perhaps a little exaggeration on the part of Le Chatelier which is to be expected from a Frenchman in the enthusiasm of the moment, but this also shows his magnanimity, for Lavoisier is his compatriot.

The importance of these papers specially of the third was not known and recognized for a long time for two reasons—(1) Natural modesty of Gibbs induced him to publish the papers in the *Transactions of the Connecticut Academy*, a provincial journal

little known in America and still less to the outside world; (2) The mathematical forms and the rigorous deductive processes make the paper very difficult reading to any one, not to speak of the chemists. At the present time, however, the great value of its methods and results are fully recognized by all students of physical chemistry. It was translated into German in 1891 (*i.e.*, 25 years after its publication) and into French in 1899 by Le Chatelier. It was explained in a more easily understandable form by Ostwald, the *doyen* of physical chemistry in the last quarter of the nineteenth century. In its simplest form a part of it is known to all students of chemistry as the " Phase Rule " which has served to classify and explain, in a simple logical manner, experimental facts of much apparent complexity.

Gibbs' other works were on statistical mechanics, vector analysis, astronomy, etc., all of them being of mathematical nature of a very high order.

Gibbs did not propound any new fundamental law of nature and did not excel in intuitive faculties like Faraday or Carnot. His was a logical mind trying to explain and expand the laws of nature mathematically and drawing inferences from them. This abstruseness of his intelligence is due to his training and environment. He came of the New England Puritan stock; his early specialization was in classical languages and mathematics, he suffered from indifferent health and lived a bachelor's life. Under the circumstances, he, an intellectual and a mathematician, cannot but be extremely logical—he never came in intimate relation with the illogical half of the human race. Being a bachelor, and not being compelled to satisfy a child's curiosities and to listen to its prattles, Gibbs' writing became extremely abstruse and incomprehensible to ordinary understanding.

The Third Law

The First Law of Thermodynamics deals with the conservation of energy, and arose out of conversion of work to heat the Second Law with the reverse problem of conversion of heat to work, and the Third Law, sometimes also called Nernst's Heat Theorem, is concerned with entropy and means of evaluating it at absolute zero. One form of the statement of the theorem is:—"Every substance has a finite positive entropy, but at the absolute zero of temperature the entropy may become zero, and does so become in the case of perfect crystalline substances."

The theorem arose out of a quest to find out the conditions which lead a chemical reaction to completion. A system under a definite set of conditions reaches equilibrium, *i.e.*, runs to completion of the reaction at its minimum free-energy-content under the circumstances. Berthelot did not make a clear distinction between free energy and the heat of reaction and was of the opinion that only exothermic reactions run quickly to completion. Lord Kelvin was misled by this opinion and unfortunately chose the Daniell cell which has a very low temperature-coefficient of the electromotive force, for verification of Berthelot's assumption. This view of the relation between heat of reaction and free energy was corrected and put on the proper thermodynamical basis by Gibbs and Helmholtz. It is easier to measure the heat of reaction than to measure the free-energy from electromotive force because many reactions cannot be run electro chemically. Therefore some method of calculating the driving force of a chemical reaction from purely thermal data has long been sought. There are equations theoretically derived, which show that the change of free energy in a reaction may be expressed as a series of terms, every one of which is obtained from measurement of heats of reaction or of specific heats except the one involving I. the constant of integration. Le Chatelier in his *Memoir* of 1888 integrated the free-energy equation and explained the importance of this integration constant. Unfortunately, owing to the inaccessibility of the journal in which his paper was published, his study of the integration constant was for a long time overlooked until 1906 when his methods were revived by Nernst in his work on the so-called chemical constants.

Gibbs-Helmholtz equation expresses the relation between free energy and heat of reaction and this involves the temperature-coefficient of the electromotive force. T. W. Richards (1902) experimentally studied the free energy and heat changes in a number of galvanic cells and showed that in a great many cells the two quantities approach each other rapidly as the temperature is lowered and that in the neighbourhood of absolute zero of temperature

the change in heat capacity and the change in entropy become negligibly small. Thus except for the fact that these cells involved solutions Richard's experiments very nearly imply the generalizations which were later to be embodied in the Third Law of Thermodynamics. Vant Hoff (1904) discussed Richards' experimental results and obtained the following rule which may be regarded as a corollary of the Third Law:--When two forms (solid or liquid) of a substance exist the one with the larger specific heat is the one which is stable at higher temperatures. Richards' extreme accuracy of whose experimental results could never be questioned, did not believe in Nernst's Heat Theorem and in his lecture classes (1911-12) he used to say "Nernst does not understand what he speaks about." Theories were never Richards' forte. Priestley discovered oxygen yet stuck to the phlogiston theory, and Lavoisier explained the role of oxygen in the phenomena of combustion.

All these attempts to secure information regarding free energy from other than equilibrium data were brought to a focus in the important paper of Nernst (1906), "Über die Berechnung chemischer Gleichgewichte aus thermischen Messungen." Herein he announced the general principle that in any chemical reaction between solid or liquid substances temperature-coefficients of the heat of reaction and of free energy approach zero at the absolute zero of temperature. As a corollary to this for any reaction in such systems the change of heat capacity and of entropy both approach zero asymptotically at the absolute zero of temperature. So with the constant values at absolute zero as the starting point one can determine the absolute values of heat capacities and entropies of systems under the limited conditions at any other temperature and state, and the integration constant evaluated.

The Third Law has not yet found such wide theoretical and industrial applications as the First and the Second.

Nernst is happily yet in the land of the living; his greatness as a scientist is recognized by all, but he has not been able to inspire love and affection from the general body of scientists except from amongst his colleagues and students. He never suffers from an excessive sense of modesty. His traditional introduction to his course of lectures on thermodynamics used to begin with the words "The First Law of Thermodynamics rests on the shoulders of many; the Second Law, on the shoulders of a few; the Third, on the shoulder of one- mine."*

This article is meant to be an humble but earnest appeal to all teachers of science not to lose the historical background of the subject they teach. Science is logical and the history of the development of every science indicates the working of the restless inquisitive human mind in its peerings into the secrets of nature. The lives of the great Masters will infuse the spirit of reverence in the young learners and will inspire them into greater strivings. A knowledge of the different ages and the leaders thereof will impart a sense of proportion and will help the students to be men of culture; and the aim of all education is first and foremost to turn out cultured gentlemen and then specialists.

* Very few scientific men will subscribe to the claims made by Nernst, on his own behalf. The Third Law was vaguely seen by Le Chetalier and Richards, but undoubtedly it was Nernst who stated it clearly, and proceeded to prove it on systematic experimental and theoretical basis. But neither the proof, nor the statement can be said to have reached finality except before the rise of the quantum theory, and completion of our knowledge of atomic structure. The works of Sackur, Tetrode and Stern, of Bose, Fermi and Dirac should not be forgotten. The Third Law, in fact, stands not on the shoulders of one man, but on those of many, as in the case of the first two—Ed., *Sc. & Cul.*

New Light on Ancient India

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SOME unexpected light is being thrown on the origins of civilizations by researches in the domain of the new science of plant genetics. It must be understood that civilization is not the work of man alone. It depends on a symbiosis of man with animals and plants who are equally his partners in that business of civilization-making. First, all civilization must start with, and rest upon, plants that can be cultivated and yield food that is sufficient and storable. Secondly, man must find as his partner an animal that can be domesticated for taking over some of his burden, by carrying loads, drawing carts, or pulling ploughs. There is also the third requisite of a plant or an animal as a source of fibres.

When the starting point of civilization is thus secured, the pace of its progress will depend upon the comparative food-and-health values of the plants and animals that are available to support a growing population. For example, the principal plants that are available, and first emerge in the history of man, are the cereals, the soya bean, and the potato, but these have not the same value from the biochemical point of view. Maize, for instance, is notorious for its deficiency in Vitamin B_2 as compared with wheat or oat. Populations subsisting on maize as their staple food fall victims to a skin-disease called Pellagra. This partly explains how the maize-civilizations of Central America (Aztecs and Incas) soon became arrested growths and were not able to achieve the level or quality of the more vigorous wheat, barley, and rice civilizations of the old-world. The other reason that may be advanced for their comparative failure is the deficiency of America in domesticable animals. The buffalo cannot compare with the cow and the llama is a very poor substitute for the horse and sheep as man's helpmates and aids to civilization.

Thus, to trace civilization to its source, the best way lies in finding where cereals and cattle were first domesticated. This requires a special scientific investigation. Such an investigation has been undertaken and is being pursued with great success by Russian scientists led by Vavilov, the head of the U.S.S.R. Department of Applied Botany and Plant Breeding. Russia to-day, inspired by Karl Marx's *Kapital* (as a substitute for the Bible), believes that to know how production is organized in a society is to know the most important thing about it, from which one can even deduce its particular philosophical bias and religious leanings. This has led Russian biologists to carry on their study from the domesticated animals and plants of to-day to their ancestors which were the means of production in primitive societies and influenced their growth. Their researches are very fruitful in the case of wheat. It is stated that while Prof. Percival's wheat collection at Reading had included about 3000 living varieties, the last counting of Vavilov collection at Dyestskoe Syelo showed it to contain as many as 23,500. These are all grown on from time to time, for it is only from growing varieties side by side that the effects of environments can be eliminated, and a nearer and nearer approach made towards their original sources. Besides, Vavilov's work is based on a very extensive range of field-work, with expeditions to Abyssinia, Afghanistan, Central and South America, and elsewhere, in search of these origins. A valuable English summary of his results is given in the Russian *Bulletin of Applied Botany and Plant-Breeding* and also in the International Genetical Congress at Berlin and Professor J. B. S. Haldane's Essays in his *Inequality of Man*.

Vavilov's investigations have established that there are two distinct groups of wheat which cannot be hybridized easily, so that each had originated from its own centre. As that centre is approached, more

and more varieties of wheat emerge, showing all kinds of character, such as purple shoots which are absent in the most cultivated varieties, and are found to be definitely primitive characters by breeding tests. It fact, for cultivated plants, the centre of diversity is also a clue to the centre of origin. Taking wild species with similar means of dispersal, it has been found that the oldest had the wider distribution. Indeed, the longer a group has been stabilized in a given area, the more species are grown there. Thus wheat is an old-world crop, and, accordingly, many more of its varieties are found in the Old-World than in America, while America takes the lead in maize.

Vavilov's investigations have brought to light 14 wheat species which are to be grouped into 3 classes according to the number of chromosomes in the nucleus. Of course, the most primitive varieties have seven pairs of chromosomes. A more cultivated variety has twenty-eight chromosome marconi wheat, growing all over the Mediterranean region, and parts of Central Asia and India. The centre of diversity in these forms is in the Mediterranean region and the actual centre of its origin is found to be in Abyssinia, which country, therefore, is to be taken to have been the original home of the agriculture that spread to Egypt and built up its civilization.

At first it was thought that the home of these twenty-eight-chromosome wheats should be traced to Syria, because these wheats have a wild prototype which originated in Syria, *viz.*, the wild emmer. This supposition rested on the theory held by geneticists like De Candolle and others that " cultivated species originated where the most similar wild form is found." Thus it was thought that wheat had originated in or near Syria because it was the home of wild emmer. But others give sterile hybrids with it, and must be traced to some other source.

Vavilov's method has been to trace the origin of cultivated plants in the track of their varieties, taking due accused of wild species. The same line of investigation is explained by Willis in his book *Age and Area*. Thus diversity as a clue to origin has led to the discovery of Abyssinia as the home of certain wheats, away from Syria, and this explains the growth of the early Egyptian civilization on the basis of those wheats.

But, as has been pointed out, there is a third group of far more important wheats which are traced to a different area. These are the forty-two-chromosome wheats which include bread wheat, club wheat, and Indian dwarf wheat. These varieties are grown to-day in Europe and North America. The centre of origin of these cultivated wheats leads therefore to the very origins of civilization.

These origins are to be looked for, as already pointed out, in the direction of diversity. The varieties of wheat grow in number from west to east. Vavilov has listed only 15–20 varieties in Europe but as many as 52 in Persia, and 60 in Afghanistan. He has found that the centre of diversity of bread wheat ultimately lies " in the Punjab and neighbouring hill-country."

The story of the origin and spread of civilization is ultimately then the story of the origin and spread of wheat. The fact was that Man started in remote neolithic times with the earliest varieties of wheat such as the small *spelt* (now given mainly as fodder in mountainous areas from Spain to Caucasus) and *emmer*. These were gradually replaced by cultivated varieties, by marcony and rivet wheat first cultivated in Abyssinia and Egypt, and accounting for its civilization, and by bread wheat which originated in " a centre near the Punjab." This region is found to be not merely the original home of the bread wheat (the stuff of life,) the source of Indian and Mesopotamian wheat, and of all the important varieties now grown in Europe and North America. It was also the original fertile source of a series of other crops or cultivated plants supplying man with valuable food-materials and other requisites of life, such as " the small-seeded types of flax and leguminous plants, Old-World cottons, some types of beans, lentils, as well as turnip, carrot, apricot or peach."

This region which is comprised in " the fold between the Hindukush and the Himalayas " is thus the most important centre of origin of crop plants in the whole world. Vavilov brings to light five other chief centres of crop plants of the world, but these crop plants were less important and useful to

human life. Thus South-Eastern Asia gave us " the hull-less barley, the millet, the soya-bean, and many fruit-trees." The regions round the Mediterranean produced "the hard wheats, the large-seeded flax and leguminous plants, the beet, the olive and the fig." Abyssinia specially was the home of these, as also the ordinary barley, emmer, certain beans and forage plants. From Central and South America came " the maize, potato, tobacco, New-world cottons and the like." Lastly, it is held that the original home of rice is to be looked for in the Phillipines.

It is also established that the crop plants must have originated in mountainous countries. The first step in civilization was not taken in any lowlying river-valley covered with dense vegetation as obstacle to be cleared by man. It began on more open ground on the slopes of hills where wild wheat or barley grew. Thus though civilization is supposed to have started from its original centres in the valleys of the Indus, the Euphrates, and the Nile, we must go farther back in time, and higher up in spaces to discover and locate the very earliest phase of these great agricultural civilizations, which were really secondary growths. Civilization started on hills and later spread down to the plains and river-valleys.

Thus biology and plant genetics must make us revise established notions regarding the origfual home of mankind or the Aryans, and the origins of civilization. The different sciences, biology, archaeology, anthropology and. even geology, are all pointing to the common conclusion that India was at once the cradle of the human race and of its civilization. She offers the most fruitful field of studies in pre-history. Quite recently the Yale-Cambridge Expedition from U. S. A. visited different parts of India in search of materials for the early history of Man and reported that the North-Western Punjab and the Sind valley are specially rich in pre-historic and palaeontological materials, while they got the best collections of primates in the Siwalik, post-Siwalik, and Salt range areas, pointing to the conclusion that the evolution of man, probably took place somewhere in the Himalayan foot-hills of N. W. Punjab and Kashmir, where was previously found the Sivapithecus jaw, an early indication of Man. The authorities of the Expedition (Dr de Terras, Mr Paterson, Mr D. Sen and others) hold that "the Palaeontologist and the Pre-historian would one day show that India was the cradle of prehistoric civilization, if not of humanity." To this we may add the earlier conclusion of Elliot-Smith that " the common ancestors of anthropoid apes and man probably occupied northern India during the Miocene Epoch " (*Early May*- a lecture delivered at the Royal Anthropological Institute) and the statement of Professor Lull., the distinguished palaeontologist: " We have to go to the region north and south of the Himalayas to find peoples whose facial characteristics best resemble those of Cro-Magnon Men, while their stature and bodily build are best displayed by the Sikhs " (' *The Antiquary of Man* ' in the Evolution of Man series edited by Bartsale). The geologist Barell also recorded earlier his conclusion that " Man and the Himalayas arose simultaneously, towards the end of the Miocene Period."*

* Read before the Second Session of the Indian Historical Congress.

Synthesis of Natural Products

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A NATURAL product can be defined as a substance that occurs in nature, animate or inanimate. The substances occurring as minerals are not strictly within the scope of this article, although there are mineral substances like petroleum which are of organic origin. The importance of the study and synthesis of natural products arises from their economic importance. Substances like indigo, alizarin etc., have been of great economic importance to this country but after their artificial preparation this country has been out of the picture altogether. The substances that have physiological interest are also of no less importance. The production of quinine, strychnine and other physiologically important alkaloids, digitalin and other cardiac aglucones have both economic and other interests. The synthetical production of a natural substance has a tremendous political significance also. Before the War, the foreign policy of England used to be, to a great extent, dictated by the consideration of the textile interests. In the post-War world, petroleum and rubber are two important considerations of the foreign offices of many countries of the Occident. It is stated that England could have realized the whole amount of the interest she had to pay to America by imposing an export duty on rubber. Henry Ford experimented on the production of rubber in tropical America so that his gigantic industry could be independent of outside supplies. If the synthetic production of rubber became a commercial proposition in peace-time conditions much of the international animosity on this score would be avoided. The question of petroleum is even more fraught with danger. The rivalry in the Middle and Near East is in a large measure bound up with this question. The researches on low temperature carbonization of coal have been intensified so that a peaceful solution of the petroleum problem can be achieved. This has been successful to a certain extent but still a lot remains to be done.

There is some confusion with regard to the use of the words "artificial" and "synthetic." The low-temperature tar of hydrogenation of coal would give a product capable of replacing petroleum, but would not be chemically identical with it. Therefore it should be better designated as "artificial petrol." Similarly hydrogenized fat would simulate butter in some respects, but its difference from natural butter can be demonstrated in a variety of ways; for example, it will show a characteristic difference of fluorescence under ultraviolet light. But the synthetic specimen of an alkaloid would be chemically and physically (also physiologically) identical with its natural analogue.

The idea to produce natural products in the laboratory is as old as the science of chemistry. Chemistry owed its birth to the desire of men to produce gold artificially. But the synthesis of natural products had the obstacle of the theory of vital force to overcome. Wohler's demonstration of the fact that substances of organic origin can be produced in the laboratory removed the last obstacle to progress. Are we not similarly handicapped even today? It is believed that synthetic chemistry will not be able to synthesize protoplasm, the unit of life. Most people believe that life on this planet had an extra-terrestrial origin. Is it outside the bounds of possibility that a suitable juxta position of the constituent elements of protoplasm will not result in an assemblage showing properties we associate with living matter?

Synthetic chemistry has revolutionized the industrial fabric of a country. In 1868, Graebe and Libermann synthesized alizarin. In 1870, Germany (of much smaller dimensions than the present) was importing 750 tons of alizarin, the colouring matter of madder. But in 1900, she was exporting 2,000 tons per annum. If we consider the case of indigo, it is even more striking. In 1897, India exported 20

million dollars worth of indigo (6 million kilos). In 1880 Baeyer synthesized indigo for the first time in the laboratory. The cost of the synthetic material would have been about thousands of dollars per pound. At any rate, the original method of Baeyer could never have been a commercial success. Did the German nation or the government tell Baeyer as we are told in this country everyday that they had no time for his intellectual recreation? Instead, five million dollars were spent on researches for evolving a workable method for the commercial manufacture of indigo. But the final clue to the successful production of phthalic acid needed for the synthesis of indigo came from 'academic sources' when the catalytic action of mercuric sulphate in the oxidation of naphthalene was accidently discovered. This illustrates the necessity of laboratory work, however unremunerative it may apparently seem. In 1897, Germany imported 50 million dollars worth of natural indigo, but in 1911 she was able to export 100 million dollars worth of the synthetic stuff to the outside world. India grew indigo on one and half million acres of land, but to-day India's production of natural indigo is negligible. Tyrian purple (the purple of the ancients) in olden days used to be prepared from a species of snails, murex brandaries. 12,000 snails gave a bare gram and a half of the dye. Its rarity and cost were responsible for its use being restricted to the wealthy and the rich. In many ancient lands its use was the prerogative to the royalty, and hence purple even to day is regarded as the royal colour. This substance was shown by synthesis to be 6: 6'-dibromo indigo and its artificial production at a very cheap cost presents little difficulty. It is no longer used in dyeing because there are so many synthetic dyes that give better shades. The dyestuff chemists have synthesized innumerable dyes and have discovered the relationship between colour and constitution. The study of natural products has given the chemists a clue as to the mode of working of nature. It has given them an insight as to the building units nature employs in forming her diverse products. With this knowledge, the synthetic chemist has gone ahead and produced endless varieties not even contemplated by nature.

The study of a natural product is important even if its synthesis is not immediately possible. The case of quinine is an instance. Although it has not been possible to artificially prepare quinine every detail of its structure is known. Basing on the model of quinine, synthetic products like plasmoquin and atebrine have been prepared having certain advantages over quinine. Again in the field of local anaesthetics, cocaine has now been almost entirely replaced by substances prepared by its analogy and but for the illicit use of cocaine, it would have completely lost its importance.

The deficiency diseases, produced by the absence from food substances of accessory bodies termed vitamins, can in most cases now be combated by synthetic substances. Recently the synthesis of vitamin A has been announced. Two of the substances of the vitamin B complex have now been produced in the laboratory. Synthetic vitamin C is a commercial commodity and the structure of vitamin E is now known with certainty.

The secretions of ductless glands which profoundly affect our metabolic processes, have been investigated and in a few cases synthetically prepared. Harrington's brilliant work on thyroxine illustrates the perseverance needed for work of this nature. The final iodination for the production of thyroxine presented difficulties which found a solution from some very systematic work on halogenation done by Datta at Calcutta. In this connection it is worthwhile to stress the importance of systematic investigation. Our workers are sometimes subjected to the criticism that the research work they are carrying out is stereotyped and very often such painstaking work is held up to ridicule. Even the Director of Public Instruction of an Indian Province found it fit to refer sarcastically to work of this nature whilst addressing one of the leading learned societies of this country. To such men and others of this way of thinking, I would say in the words of Carlyle that "Work is Worship." Every systematic honest endeavour has its place in the scheme of things. The criticism of scientific work should not be based on the criterion of its immediate benefits.

There is a growing feeling in this country that all we need is an army of men versed in the processes of technical chemistry and pursuit of pure sciences could be stayed till the country is in a

better position. To my mind divorce of technical chemistry from pure chemistry would be like teaching a boy how to solve extras in geometry without giving him a thorough grounding of the book propositions. There is a talk that higher education should be made self-supporting, and whatever higher education there is should pay its way. If that principle had been adopted in Europe we can well imagine what would have been the state of their sciences to-day. It is often said that the present system of higher education has failed in this country and it should be replaced. It is easy to make this kind of statement. At any rate, such statements can hide a lot of " shortcoming " for the time being. But a little reflection will convince any one that during the short spell of two decades since the inauguration of the present system of research degrees, our universities have produced quite a number of outstanding scientific workers who would have been a credit to any country. When a boy I was given a small plot of ground for gardening. Often, a few days after planting a tree I would pull it up to see if it has taken roots. I had no garden left in a short time. This habit of pulling a thing up by the roots to see how it is thriving if applied to our educational system can produce nothing but disaster.*

*A popular lecture delivered under the auspices of the National Institute of Sciences of India at Bombay.

Chance in aid of Scientific Researches

SCIENTIFIC discovery can be divided into three phases: birth of the idea, its control or experimental verification and its practical realization. Only the last two points are susceptible of being presented in a public exhibition. But the first phase cannot be rendered concrete. The knowledge of the latent process of scientific discovery, the qualitative and quantitative laws of the creations of ideas have not yet been elucidated. Do they really exist? We know nothing. The marvellous work of thought escapes us totally and its analysis permits us at the most to predict certain regularity in the formation of the idea. There exists a profound analogy between scientific research and the work of the artist in the first phase of the process of creation. Some examples will suffice to illustrate the same:

Leonard de Vinci- mathematician, physicist, astronomer and artist; Blaise Pascal--illustrated mathematician, physicist and philosopher; Borodine -Russian chemist and reputed musician; Wilhelm Ostwald--philosopher and physicist; Kurbatow chemist and historian.

Long since chance is no more regarded as a unique source of discoveries but one can cite numerous happy cases where it has played an important role. Let us recall the discovery of saccharine by Fahlberg, that of thiophene by V. Meyer and the determination of the catalytic role of the oxides of nitrogen in the manufacture of sulphuric acid by Clement and Desormes. It is also a pure chance which led Verguin to the discovery of fuchsine and Perkin to that of mauveine during his researches on the synthetic preparation of quinine. It is by the breaking of a thermometer during the sulphonation of naphthalene that Saoper of the " Badische " prepared unintentionally phthalic acid which gave a formidable impulse in the industrial synthesis of indigo. Owing to a crack in the vessel the nitroglycerine contained in it impregnated the porous earth in which Nobel packed his vessel. The explosive character of this earth did not escape the notice of the inventor and dynamite was born. The discovery of iodine and bromine were facts of pure chance. The latter element was isolated by Balard in 1826. It is reported that Liebig who had remarked on the brownish red vapour without attaching much importance to it, ironically said, " It is not Balard that discovered bromine but bromine discovered Balard." We will conclude with another anecdote on the role of chance. During a ball given by Charles X at the palace of Tuillaries the candles

which illuminated the hall gave rise to extremely irritating vapours and necessitated the evacuation of the salon. Balard, the royal chemist and director of the factory of Sevres, asked his son-in-law, young Dumas, to ascertain the cause of it. The vapours were formed of hydrochloric acid arising out of the fixation of chlorine used in the bleaching of the candles. Dumas was able to demonstrate that organic compounds are susceptible to combine with the halogens and thus to announce his unforgettable theory of substitution.

One can analyse the role of necessity, diate want and struggle for existence in discovery. It is sufficient to recall that France owed industry of sugar from beet and Leblanc's process of manufacture of sodium carbonate to the continental blockade.

Another phenomenon worth noticing is the simultaneousness of scientific discoveries. It is not an exceptional fact that two or more persons foreign to one another happen to announce the same scientific truth or to resolve the same practical problem at the same time. This phenomenon is virtually universal and very frequent. The memories of Darwin and Wallace on natural selection were both read on the 1st of July, 1858, at the Linnean Society of London. Cros and Ducos of Hauron exposed their processes of colour photography on the same day in 1869 at the French Society of Photography. Cailletet and Pictet discovered at the same time the liquefaction of gases. Restricting oneself in the domain of chemistry, one can still cite the discovery of oxygen by Priestly, Scheele and Lavoisier; of chloroform by Soubeirán in France, Liebig in Germany, and by S. Guthire in the United States. Mendeleef and Lothar Mayer in the same year came to announce the Periodic Table—classification of Elements by the increasing order of atomic weights. American Hall and French Heroult within the interval of one or two months perfected the industrial manufacture of Aluminium. Nilson discovered Scandium and Clive was late by a few weeks in announcing the discovery of the same. Crooks in England and Laney in France independently discovered Tha

Only one plausible and satisfactory hypothesis can be applied to this simultaneity. Discoveries mature at a given period. Society poses to the savants a certain number of problems which are expressions, of a practical or intellectual need born of previous discoveries. In the domain of pure science, the problems are suggested by the degree of advancement of a particular culture. This culture is determined by the teachings of masters, organization of laboratories, previous publications and finally by the general evolution of the society considered.

In the domain of applied science it is acted on, above all, by the industrial demand. The dominant factors here are utilitarian instinct, desire of well-being, competition, the lowering of the cost of production, etc. But this determinism is not the only factor of the simultaneity of discoveries. One must equally take into account the necessary succession of great scientific discoveries. Borrowing the formula of Mentre one could say that infinitesimal calculus cannot be born before analytical geometry Newton before Kepler.

P. B. S.

Chemistry of Sterols and the Alleviation of Human Sufferings

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THE knowledge of the chemistry of sterols and related compounds (cholan chemistry) has during the last few years, undergone such drastic and far reaching changes through the continuous experimental works of Wieland, Windaus, Ruzicka, Diels, Rosenheim, Butenandt, Fernholz and their pupils, that it forms to-day not only an interesting but the most important branch of physiological chemistry.

Sterols have been found to possess various kinds of biological activities and to have close structural relationship with other physiologically active substances such as bile acids, vitamin D, sex hormones, saponins, cardiac glycosides and cancer producing substances. From the knowledge of the structural similarity between sterols and these substances of biological importance it has also been possible to prepare them from sterols in the laboratory in large quantities. In one word, it can be said that recent developments in this line, have contributed much towards the progress of medicinal science and towards the alleviation of human sufferings.

What Sterols are.

Before proceeding further it is necessary to touch upon a brief account of the nature, occurrence and classification of sterols. Sterols, the unsaturated solid alcohols (steros solid) of high molecular weight are regular constituents of oils and fats, both of animal as well as vegetable origin. These are neutral and comparatively stable substances and occur partly in the free state and partly esterified with higher fatty acids. Sterols with respect to their origin can be divided in three main classes:—(1) animal sterol (zoosterol) (2) fungus sterol (mycosterol), and (3) plant sterol (phytosterol). The important sterol occurring in the animal body is cholesterol ($C_{27}H_{46}O$) which was known since the eighteenth century, (Conradi, 1775) as the chief constituent of human gall stones. It has been so named from its occurrence in bile (choles bile). It is the characteristic sterol of higher animals and is present in all cells of human organism and in large quantity in the brain, nervous tissue, in suprarenal cortex and in egg yolks. The solid matter of the brain contains as much as 17% of the substance. It also occurs in lanolin, the wool fat of sheep, as esters of higher fatty acids and in the feathers of birds as an ester of cilicic acid.

Ergosterol, the most important mycosterol and the so-called mother substance of vitamin D, was for the first time isolated in the year 1889 by Tanret from ergot, the fungus of rye. It has also been found in the yeast and animal body. It is present in the skin to the extent of about 1/600 of the total sterol. The present formula $C_{28}H_{44}O$, has been suggested only in the year 1932.

Stigmasterol, the characteristic plant sterol, was isolated from soyabean by Windaus in the year 1906. It has been found to be present also in beet oil, coconut oil and cocoa butter. The present formula $C_{29}H_{48}O$ has been developed in the year 1930. The sterol, as will shortly be shown, is the mother substance of female sex hormone luteosterone.

Several other sterols such as zymosterol, fucosterol, lanosterol, agnosterol, calosterol, cerevesterol etc. have been isolated from various sources, but details about their internal structure and physiological activity have not hitherto been known.

Functions of Sterol

Sterols were formerly believed to be merely waste products of metabolism. But it is now held

that they have got some protective function and save the body cells to some extent, against the entrance of certain poisons such as the snake venom which has a property of dissolving red blood corpuscles. From the occurrence in the bile and from the knowledge of its structural similarity with bile acids it is also (though not found definitely) that bile acids, which as will shortly be seen are of great importance to the system, owe their origin to the naturally occurring sterols.

Bile Acids and their Functions

Bile acids are the important constituents of bile and generally occur as sodium salts in conjugation with the amino acids, taurin and glycin (*e.g.* taurocholic acid and glycocholic acid). Other bile acids present in the human bile are deoxycholic acid and cheno-de-oxycholic acid which are of considerable importance.

Important functions of bile salts are (*a*) stimulating the secretions of bile, deficiency of which causes serious digestive disorder and (*b*) forming the so called water soluble "Choleic acids" from some of the water insoluble compounds.

Wieland and Sorge found (1916) that de-oxycholic acid which is an important constituent of the human and cattle biles formed co-ordination compounds with fatty acids excepting formic acid called "Choleic acid." Stable addition compounds are also formed with cholesterol, with certain aliphatic and aromatic hydrocarbons, certain alkaloids and also with esters, ethers and phenols. Thus water-insoluble substances including fats and higher aromatic hydrocarbons can be brought into aqueous solutions in the form of sodium salts of cholic acid. Wieland and Sorge suggested that the dissolving power of the bile may be due to the "Choleic acid principle." But it must be pointed out that only de-oxy-cholic acid as opposed to other bile acids can form choleic acids and *help facilitating* absorption.

Sterols and Bile Acids

The view that sterols might have some genetic relationship with the bile acids has been developed since the year 1879 when Lachinov gave some hint about the point. The structural resemblance between sterols and bile acids, was first verified experimentally by Windaus and Neukirchen who were successful in converting cholestane the saturated hydrocarbon corresponding to cholesterol into allo cholanic acid (a bile acid derivative) and corpostane into cholanic acid. Works of Wieland and Jacobi threw further light in this point. They succeeded in reversing the process. They started with ethyl cholanate (a bile acid ester) and through the action of Grignard's reagent and subsequent oxidation with chromium trioxide, found corpostanone 24, and from this they obtained corpostane, the saturated hydrocarbon corresponding to corposterol, by reduction of the CO-group.

Vitamin D and its relationship with Sterols

Vitamin D which in the form of solution in oils is now so vastly used as an antirachitic medicine for infants suffering from rickets and as an important calcifying factor during the period of pregnancy and lactation has also a close genetic relationship with the class of substances called sterols.

McCollum and co-workers in the year 1922 put forward the idea that vitamin D was distinct from vitamin A. Till the investigations of Schultz and Zeigler the generally accepted view was that cholesterol was the precursor of vitamin D.

It was soon revealed that the selective absorption shown by cholesterol was due to the presence of minute trace of a contaminant in it, and pure cholesterol, obtained by reconversion from the dibromide, could not be made to develop antirachitic activity. This led to the search for the "impurity" that was the precursor of the antirachitic factor and in the year 1927 Windaus and Rosenheim almost simultaneously announced that this impurity might be ergosterol. This declaration gave an impetus to the workers in the line of sterols; and subsequently investigation of a larger number of sterols and their derivatives pointed to ergosterol as being the specific pro-vitamin D.

Since this relation between ergosterol and vitamin D had been established, the sterol chemistry became a subject of considerable physiological importance. Attempts were then made to isolate

the chemically pure vitamin D; and within a few years, through the investigations of Askew *et al* on the one hand and of Windaus and his co-workers on the other, crystalline vitamin D (called calciferol by Askew and vitamin D_2 by Windaus) was isolated. By ultraviolet irradiation of ergosterol a number of isomerides were formed, but none other than calciferol has got any antirachitic property.

Different Varieties of Vitamin D

Some biological evidence however soon came to be prevalent against the view that ergosterol is the only source of vitamin D. By feeding chicks and children with cod liver oil it was found that activity of this oil against rickets was about 25 100 times more than an equivalent number of rat units of calciferol. Waddel soon pointed out that though the irradiation product of crystallised cholesterol could not cure rickets in rats, it had a much more greater potency in curing rickets in chicks than an equivalent rat unit dosage of calciferol.

Only recently the idea about the problem of conversion of a sterol into an antirachitic factor, has been revolutionised. Windaus, Lettre and Schenck have found that a sterol irrespective of the molecular weight, can be made to develop antirachitic activity, provided it possesses two ethenoid linkings in the rings, in the same position as in ergosterol. It has been found that 1 mg. of irradiated 7 dehydrocholesterol prepared from cholesteryl acetate is equivalent to 8000 international antirachitic units.

Thus it is seen that the idea about the origin of vitamin D has recently been changed through the works of Windaus and his associates. It has been found very recently that just like 7 dehydro cholesterol, 22-dehydro ergosterol also can produce on irradiation a substance possessing high antirachitic potency and showing the same characteristic absorption maximum at 265 m, as vitamin D_2 and D_3. This goes by the name vitamin D_4.

Through the advancement of knowledge in the line of the chemistry of sterols it has not only been established beyond doubt that sterols irrespective of their molecular weight can act as the precursor of vitamin D, but it has also shown new ways and means for the relief of suffering humanity.

Sterols and Sex-Hormones

Another interesting feature is the structual similarity between sterols and the secondary sex hormones. A hormone $C_{19}H_{30}O_2$ (androsterone), which controls the secondary sexual characters in the male, has been isolated from male urine by Butenandt and Teschering. Within a few months the startling discoveries by Ruzicka, Goldberg and Brungger, have not only served to support the constitution of androsterone but have formed a bridge over sterols and the most physiologically active substances like hormones, and have brought forward a stimulus for the investigations of the chemistry of sterols. The authors have succeeded in converting cholestanyl acetate into an active isomeride of androsterone and epi dihydro cholesterol into androsterone, by method of oxidation with chromium trioxide.

From the time it was supposed that ergosterol was the only pro-vitamin D, the importance of other sterols and their derivatives, was lessened to a great extent. But the works of Ruzicka and his co-workers (*loc. cit.*) in the year 1934, have renewed interest in the subject by showing that inactive sterols and sterol-derivatives can also be made to acquire physiological activity only through some chemical treatments.

The point has further been elucidated through the synthesis of the active principle of corpus luteum hormone luteosterone ($C_{21}H_{30}O_2$), almost simultaneously by the German scientists Butenandt and Fernholz, from a naturally occurring well characterised plant sterol named stigmasterol.

The scarcity of sex-hormones both male and female has thus been removed and the trouble in isolating those substances from urine, testes, ovaries etc. has been done away with. People suffering from insufficient or abnormal supply of these secretions of sex glands will now have the fortune of getting an adequate supply of sex hormones, which can be manufactured from sterols.

Interconversion of Sex-Hormones

An astonishing result has recently been obtained in Butenandt's Laboratory where, Dannenberg has

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succeeded in converting the male hormone androstandione ($C_{19}H_{28}O_2$) which has been isolated from testes into a female one (1:2 androstendione) only by insertion of an additional double bond in 1:2 position. This new substance has the power of causing complete oestrus in a castrated mouse when injected but cannot cause comb growth of capon which is the characteristic property of the former one.

An interesting substance has also been reported to be formed from a male hormone de hydro androsteron ($C_{19}H_{28}O_2$). This compound has been termed as androstendiol ($C_{19}H_{30}O_2$) and has the peculiar power of showing bi-sexual properties *i.e.*, of causing comb growth of capon and oestrus formation of castrated female mouse.

Whether some such transformation takes place in the animated beings are questions still to be solved.

Sterols and Saponins

It has been shown that saponins, the glucosides present in the plants which have the property of acting as emulsifying agents as soap solutions and thus causing oils and fats to be absorbed easily. have close structural resemblance with bile acid and hence with sterols. Zigogenin ($C_{27}H_{44}O_3$) has been converted to aetio-allobilianic acid ($C_{19}H_{31}O_4$).

Sterols and Cardiac Poisons

Though the compounds classed as cardiac poisons (Uzarigenin, Strophanthidin etc.) were unknown to the natives they made use of the crude extract of the plants in which these occur, as their arrow-poisons.

The active principles have now been isolated in the purified condition and have been and are being used as medicines to cure cardiac weakness and irregularities.

That these substances are also members of the sterol group has been proved by the formation of aetio-allo cholanic acid ($C_{20}H_{32}O_2$) from uzarigenin ($C_{23}H_{34}O_5$).

Sterols and Carcinogenic Substances

Through the light of the modern research it has been established beyond doubt that cancer is not produced by any organism but it is formed by a peculiar method of cell division and destruction of the tissues at a greater speed.

In the year 1933 Cook and Dodds of the Royal Cancer Hospital, London and Wieland and Dane of Germany announced almost simultaneously that methyl cholanthrene ($C_{21}H_{16}$) obtained from a bile acid, 12-Keto cholanic acid, is a very active cancer producing substance.

Now as the constitution of this product has been known and the mechanism of working of this carcinogenic substance has also been ascertained to a certain extent we can hope that through the advancement of the knowledge in the branch of the chemistry of sterols and related compounds, science will soon find out means how to prevent its formation and to effect its cure.

Conclusion

Thus it is seen that the recent observations regarding the production of antirachitic substances from sterols other than ergosterol, transformation of more than one sterol to the highly active sex-hormones of both types male as well as female and conversion of sterol and sterol derivatives to bile acids, carcinogenic substances etc. have added greatly to the interest in the subject and have led to the search for new sterols and sterol derivatives in the plant and animal kingdom.

Nobel Laureate in Physics for 1938 —Professor Enrico Fermi

R. C. Majumdar
Bose Research Institute, Calcutta.

To Dr Enrico Fermi, the most outstanding Physicist of Italy has been awarded the Nobel Prize for Physics this year for his "*Discovery of new elementary radioactive substances engendered by Irradiation of Neutrons and other researches on the reaction created by neutrons.*" Born in 1901, Fermi got his preliminary education in Italy and later on in Germany under Prof. Max Born in the University of Göttingen. He is at present serving as Professor of Physics in the University of Rome.

Fermi's first work of importance was an extension of Saha's theory of Thermal Ionisation which he worked out in 1924 in collaboration with Prof. Urey of America. The work which brought Fermi to the forefront of Physicists is the discovery of Fermi Statistics, (the law of velocity-distribution of electrons in thermal equilibrium) a work which was inspired by that of Prof. S. N. Bose of the Dacca University. To quote the words of an eminent physicist, "the two statistics pertake of the nature of the two world-regions from which the two physicists hail. In Bose's system there is no limit to the number of particles herding together just as we find with Easterners. In Fermi's there is a very strict Law, and herding is strictly regulated as in all western countries." Bose's Law is found to be true for light corpuscles, and the particles with an even mass number; Fermi's is found to be correct for electrons, protons, and particles of odd mass number. The ideas thus introduced were responsible for throwing light on many important problems in Physics. On the basis of this theory Prof. Sommerfeld of Munich was able to explain the puzzle of electrical conductivity of metals and a number of workers following the illuminating work of Prof. Fowler of Cambridge were able to throw much light on the constitution of those wonderful stars called "White Dwarfs" in which "matter of the size of a rupee weighs more than a ton and requires a heavy crane to lift it up" (Eddington). In 1928 Fermi was successful in calculating the Potential field inside a complex atom by assuming that the electrons inside it obey his newly discovered statistics and this work threw much light on the distribution of elements in the periodic table. This method of calculation of statistical field by Fermi was responsible for many important developments in atomic as well as in nuclear Physics during later years. Another important work of Fermi consisted in deducing a theoretical formula for the evaluation of the magnetic moment of nuclei from a knowledge of hyperfine structure-separation of the energy levels of atoms. In 1929 he successfully developed a general quantum theory of electromagnetic field in which charges were present. He also brought to the fore front the inherent defect in such a formulation. He showed that the general field could be separated into two parts transverse and longitudinal; the former one behaved just like the ordinary rediation field of Maxwell Dirac, showing the characteristic properties of a particle under Lorentz-transformation and was responsible for emission, absorption, etc., whereas the latter one, the longitudinal part of the field gave rise to the electrostatic interaction (Coulomb field) between charged particles and therefore contained terms which became infinite. They represent the self energy, *i.e.*, the energy of the static field of a point charge. No satisfactory solution has yet been found to this fundamental difficulty of infinite self-energy as pointed out by Fermi in 1929-31. A similar theory of Quantum electrodynamics in a more general form was also independently developed by Heisenberg and Pauli.

Shortly after this Fermi turned his attention

to the problem of Radio-activity on which was focussed the attention of the scientists all over the world. When Heisenberg was seriously busy in building up the nucleus with Protons and Neutrons, instead of Protons and Electrons as assumed earlier, Fermi came forward in 1934 with a theory of β-ray (electron) disintegration from the radio active substances, which has far reaching consequence in our understanding, not only of the nuclear phenomena, but also of the nature of the physical world. The outstanding difficulty with the β-ray disintegration was to realise how the electrons emitted by a nucleus which has got perfectly well defined quantum levels, could have a continuous distribution of energy amongst themselves. This discrepancy led Bohr to advocate the sacrifice of the energy-conservation Law for nuclear process, whereas Pauli was not prepared to give up this time-honoured law of Physics and asserted that during β-ray disintegration a new kind of particle was simultaneously emitted along with the electron and carried away the balance energy. This new particle is called *neutrino*, a particle having no charge and practically no mass. In 1934 Fermi constructed a very ingeneous theory of β-ray disintegration based on the hypothesis of Pauli, in which the law of conservation of energy holds good, and explained, at least qualitatively, the form of the energy distribution curve of the emitted electrons. He thereby assumed the virtual existence of a " field," which caused the transition of the nucleus from its neutron to proton state with the emission of electron and neutrino. In describing the interaction of this field with the nuclear particles Fermi introduced a constant term having the dimension of length. The process is analogous to that of the emission of a quantum from a Bohr atom in its transition from a higher to a lower state under the influence of the electromagnetic field. With the help of the Fermi-field Heisenberg was able to explain the phenomenon of " shower " produced by cosmic rays. Fermi's theory also explained, as shown by Wick, the anomalous magnetic moments of the proton and the neutron, which are about three times and -2 times the nuclear Bohr magneton respectively instead of and zero nuclear magneton as expected from Dirac's theory of elementary particles. His theory has thus opened a new path for studying the baffling problem of constitution of the nucleus and the laws prevailing amongst its inhabitants. But Fermi's theory goes further. The new constant introduced by Fermi is of a great fundamental nature. As already emphasised by Heisenberg, this fundamental constant of Fermi is expected to revolutionise our knowledge of the physical world just like the constant c, the velocity of light revolutionised the conception of space and time (Einstein's theory of special Relativity) and the constant h, the Planck constant, brought a revolutionary change in the conception of Wave and particle (Uncertainty principle-Wave mechanics).

All these works are on theoretical physics. Now what is very amazing in Fermi is that all on a sudden one finds him working in the laboratory, busy in bombarding the Nucleus of atoms with Chadwick's Neutron which has no charge but a mass nearly equal to that of the Proton. This experiment of Fermi yielded results of fundamental importance and has become now very celebrated. The idea of bombarding nucleus with heavy electrically charged Alpha particles and causing artificial nuclear transformation was first successfully carried out in practice by Lord Rutherford in 1919. By bombarding Nitrogen nucleus with the fast Alpha particles of RaC' he observed that the protons were ejected, the original nucleus being converted to a heavy isotope of Oxygen. His work was soon followed by his students in Cambridge and by Bothe, Curie and Joliot and others on the continent, who made a systematic study of the artificial radioactivity caused by bombarding the nucleus of different elements with the *Alpha particle* obtained from different sources. In course of these investigations Curie and Joliot observed in a number of cases the emission of positive electrons after the source of the bombarding Alpha particle was removed. This sort of radioactivity as induced by the nuclear reaction behaves very similar to the ordinary radio activity of the radioactive elements and is called *Induced Radio-activity*. Now Fermi perceived that the *Neutron*, since it has no charge, would penetrate straight within the nucleus without being stopped by its surrounding electrical forces and would therefore be the most powerful projectile for attacking the nucleus or the heart of the atom. Though the first neutron disintegration was obtained

by Feather by bombarding Nitrogen with neutrons, when alpha particle was emitted, it was, in fact, Fermi's systematic investigations with neutron bombardment, which have opened a new avenue in the field of nuclear physics. Fermi's experiments with Neutrons may be divided into two groups namely, those performed with fast neutrons (about 10 MeV), which are emitted, for example, from a radon + beryllium source, and those with neutrons slowed down to thermal energies (*i.e.* to energies of gas molecules at room temperature, which are about a few volts only) by passage through a hydrogen containing material.

Fermi's discovery of induced radioactivity in 1934 by neutron bombardment gave a vigorous impetus to physicists for the development of Nuclear Physics. By bombarding many elements with fast neutrons, Fermi observed emission of electrons when the source of neutrons was removed, activity being thus induced in the bombarded elements. The new radioactive isotopes thus produced have the atomic number either less by one or two units or identical with that of the original nucleus. Fermi also found that in many cases the neutron was directly captured by the nucleus without emission of any nuclear partcles, the excess energy being emitted in the form of γ-radiation. This sort of radiative capture of the incident neutron is generally expected for the case of heavy elements, where the potential barrier is sufficiently high to prevent the charged particles to leave the nucleus. The most outstanding discovery by Fermi and his co-workers in this connection is that of a new radio active element obtained by irradiating uranium with Neutrons. They observed several periods of induced activity and proved by means of chemical test that the active bodies must be transuranic elements, their atomic number being greater than 92. The researches of Meitner and Hahn have confirmed the existence of some of these elements; one of them is probably Eka-Re (Z 93) and the other product an Eka-Os (Z 94), and still another Eka-Pt (Z 96).

The climax came, as remarked by Bethe, when the Rome group *i.e.*, Fermi and his coworkers discovered the so-called ' water effect ' *i.e.*, when they observed that the activity of the simple capture process of the neutrons by many elements was enormously increased when the source and the irradiated element were surrounded by a hydrogen containing material, like paraffin or water. This was explained by Fermi as due to the slowing down of the neutrons by collisions with hydrogen atoms. The bombardment of Nuclei by slow neutrons showed another very remarkable effect, namely selective absorption of these neutrons. The neutrons which produced strong activity in one element were found to cause no appreciable activity in others. These capture reactions induced by slow neutrons are very fundamental in investigating nuclear structure. Infact the discoveries of these reactions with slow neutrons by Fermi, together with those of the resonance levels of the nucleus have led Prof. Bohr to formulate his recent theory of nuclear reactions.

Fermi is only 37 years of age and has built up a fine school of Physicists about him. He was elected many years ago a member of the Society of Lincei, the oldest and the celebrated scientific Society in Italy." The Society is so called because its members are supposed to possess an extra vision which enables them to see through walls of ignorance, like the mythical Lynx which can see through material obstacles. Fermi is a noted Alpine climber. He has got friends in scientific circles all over the world."

The Message of Muscles and Nerves

Basu Kumar Bagchi

PHYSIOLOGY investigates the function of living structures including nerves and muscles; it has done that for centuries. But not until about the end of the 18th century did it know that nerves and muscles can "talk", *i.e.*, can give electrical "messages" which accompany their chief functions but which are not their chief functions in the body economy.

When Mr Galvani of Italy and his good, helpful wife accidentally discovered in 1786 that the leg of a dead frog hung with a copper hook from an iron ballustrade gave a spasm the moment it touched the latter, they came across a unique phenomenon. The significance of it in all its bearings is not realized even to-day. The phenomenon was the electrical manifestation of living tissues brought out in this case by contact with dissimilar metals. Thus, amidst crude surroundings, electrophysiology, a cousin of physiology, was born. To-day most sensitive radio valves with delicate electrical appliances costing hundreds, even thousands, of rupees and amplifying the tiny currents in the living tissues as much as 2 million times to make them recordable, constitute the equipment of some of the modern electrophysiological laboratories. Galvani would gape in astonishment if he could be resurrected and see all this. In the last fifteen years or so Europe and America have made remarkable progress in electrophysiology. But in India, barring the great work of the late Sir J. C. Bose and his co-workers, advanced electrophysiological research has been conspicuous by its absence.

In addition to its own planning of ingenious experimental techniques, electrophysiology has had to depend to a great extent for its advance upon the development of increasingly sensitive and accurate electrical recording machines. Schweigger (1811) devised the first galvanometer to indicate electrical changes. Oerstead's galvanometer (1821) was much better than Schweigger's. Nobili's astatic needle galvanometer (1827) was first used for measuring the electrical properties of frogs' muscles which were thought to be due to what was then called "animal electricity"—a very unfortunate and confusing term. There was a regular scientific war over this affair of animal electricity between Galvani and Volta and their followers. Galvani thought electricity, or rather animal electricity, was in animals but not in metals. Volta thought it was in dissimilar metals causing animals in contact with them to react electrically, but not in animals. As Waller pointed out later "Both assertions are correct and both denials are incorrect," we now know animal currents exist and so do metal currents.

The famous du Bois-Reymond discovered in 1848 many important electrical properties of animal tissues such as the negative electrical current, called injury or rest current, which occurs when the upper surface of a nerve is connected by a wire to any of its cut ends. We shall skip the brilliant researches of J. Muller, Helmholtz, and others only mentioning that Helmholtz first discovered the rate of speed of nerve impulses, which is 88 to 99 ft. per second for a frog's motor nerve. This speed is infinitely slower than that of electricity. Quite a surprise at that time! Lippman's capillary electrometer (1872) enhanced the accuracy of electrical recording. Einthoven's string galvanometer (1901) although more sensitive than Lippman's instrument has had quite a bit of inertia. Then followed different types of oscillographs more advantageous than the string galvanometer and considered fairly good for ordinary purposes even to-day. However the inertia-less cathode ray oscillograph of the modern type (first made by Braun in 1890), the most accurate of all, reproducing without distortion electrical oscillations as high as 200 million per second, has proved to be one of the greatest boons to scientific workers of to-day including those who want to know what nerves and muscles have to "say". But even that would have

been inadequate if it were not for the amplification devices used with it which modern electrical engineers have placed in the hands of electrophysiologists.

One of the greatest physiologists of all time is Sir C. S. Sherrington of England, a Nobel laureate. He has done more than any other single man in modern times to prove the integrative action of the nervous system. Sensory nerves convey into the spine and brain information of the world or inner part of the body impressed on the sense organs, motor nerves convey " orders " from the spine and the brain in response to the information received, to the muscles and glands; the nervous system selects, integrates, co-ordinates and elaborates the information and the responses in accordance with environmental demands and its own internal patterns. These are its functions. It is a vast and most intricate telephone and controlling system in one. Muscles are, in a sense, slaves to the nerves. Muscles move bones, make postural changes knead and carry forward food, pump and push blood, inflate and deflate lungs, make us blush and pale, and do many other things, but all these functions are made possible mainly through the influence of the nervous system, their master, especially in higher animals. Where mind comes in is a point that is beyond the province of orthodox physiology.

An interesting problem of modern electrophysiology is to record and analyse the electrical messages that nerves and muscles give out when they discharge the above-mentioned functions. You cannot only listen to them on the loud speaker but see them right before you as they flash on the screen amplified by the wonderful machines of to-day. These electrical messages come from the nerve impulses. But what are the nerve impulses? Nerve impulses going over a nerve or a nerve fibre are not exactly like the ordinary flow of electricity or electrons through a metallic wire, yet they are similar in many respects. Professor Adrian of Cambridge, a Nobel laureate, and others, have maintained that they are like discontinuous " bullets from a firing machine gun " and not like a continuous stream of water running out of a hose. They are more or less akin to a burning fuse of a fire-cracker. In technical language they are the progressive, step-by-step depolarization of the semi permeable membrane of the nerve fibres—a sort of moving exchange of ions or charged electrical particles between the inner and outer surfaces of the nerve fibres. Further, an extremely gradual impact of a certain type of stimulus will not start a nerve impulse, and after an effective stimulus starts it a second stimulus of equal value, administered within one thousand of a second of the first or even within ten thousands of a second as in the case of some slow-conducting nerve fibres, will not evoke a nerve impulse (the nerve or the nerve fibre remains refractory) *i.e.*, cannot then be whipped into any activity.

From the results of experiments on animal nerves conclusions have been drawn in regard to men's which are not very far from the truth. Suppose some one touches your skin quickly and lightly (say with a 10 gm. pressure). The touch will cause a temporary deformation of your touch organ on the skin which acts like a trigger and starts a series of nerve impulses running over the nerve fibres connected with it. The nerve impulses will race quickly along over the fibres in steps of anywhere from 10 to 100 per second (technically called frequency) until they reach your brain and you have the sensation of touch. The strength of the steps (the nerve impulses) is always the same according to the all or-none law in the sense that the nerve impulses appear either with maximum strength or do not appear at all; they cannot appear half way. But the number of steps per second may be more or less, that is the frequencies of nerve impulses may be fast or slow. Suppose some one presses your skin increasingly harder. Two things will happen. First, the more intense the touch stimulus, the greater is the number or touch organs and nerve fibres called into play. Second, the impulses will take many more steps per second (*i.e.*, will have a much higher frequency) in going to the brain, over each of the nerve fibres and the more intense will be your touch sensation. So modern scientists believe that the intensity of a sensation is proportional to the number of nerve impulses per second (Adrian). That is true provided there is nothing to distract your mind and provided you feel the different intensities of a sensation, which you of course do but which are so difficult to measure scientifically.

Now suppose again that a coin is placed on your palm and kept there for a few seconds. At

first there will be a burst of impulses, say 100 to 200 per second, over the nerve fibres connected to the palm, then the impulses will become less and less until they are irregular and scarce. And the exciiatory process of your touch organ becomes less and less too. This is the phenomenon of adaptation. Psychologically also you begin to get accustomed to the " feel " of the coin. Thus, although far from solving the body-mind problem, electrophysiology, by discovering the minute electrical behaviour of active nerve fibres, is at least making that big old " gap between stimulus and sensation a little narrower."

Erlanger, Gasser and others of America have further analysed the nerve impulses by their electric message picked up from the surface of a nerve. From the electrical message they can roughly estimate the speed-capacity and function of some of the nerve fibres of which a nerve is composed and which in reality send these messages. The electrical message can be instrumentally converted into visible forms of five distinct types with their characteristic timing and strength, each type having been given a name. An alpha message looks like a very tall spike flashing on and then off within about half of one thousand of a second; beta hangs on the side of the alpha like a hump; gamma, following it, is a small saw toothed projection. These three together are called *A*. Then follow *B* and *C* messages which look like two very low elevations in outline. These messages are slower than the alpha, flashing on and then off over an active nerve in a few thousandths of a second. Some of the fattest of the nerve fibres, such as of a frog's sciatic nerve (in its leg) containing 854 medullated nerve fibres, each with a diameter of from 13 micron to 18 micron (a micron being one thousandth of a millimeter) have when stimulated a strength in their *A* message to the extent of from 2.5 millivolts for alpha down to .1 millivolt for gamma (one millivolt being one thousandth of a volt). These fattest nerve fibres are the fastest of all, able to carry nerve impulses in the shape of alpha, beta and gamma over them at a speed of from 140 feet to over 300 feet per second. That includes the speed of mammalian nerves. The messages *B* and *C*, however, are very weak; they are whispers, as it were, of very thin nerve fibres, 5.5 to 2.4 micron in diameter. Some of these thin fibres carry nerve impulses over them slower than a fast running dog, 2 to 14 feet per second. The truth has been mathematically expressed thus: the conduction rate of nerve fibres varies not as their diameter but as the square of their diameter (Erlanger).

Now though it has not yet been possible to relate all the nerve fibres of various thicknesses to their functions in terms of their electrical message some facts like the following have emerged. Most of the motor nerve fibres which carry " orders " down from the brain and the spine give only the alpha message, some slow ones only *B* or *C* message. Some of the sensory nerve fibres which carry the cutaneous information (information from the skin) up to the spine and the brain do not give the alpha message; they give only beta, gamma and *B* messages. Some of the small diametered fibres flash only *B* and *C* messages. They mediate involuntary activities, they also slowly carry the information of pain. In fact the information of pain is not carried by any other type of fibre. Physical pain is not simply dependent upon sense organs, or the head and any and every type of nerve fibre connecting the two as was formerly thought. A fairly specialized line has to transmit pain information before it can be felt as pain in our consciousness.

Let us come to so ie work done on intact human beings. Take human muscles. When you move any muscle or muscle group such as the biceps, nerve impulses travel down from the brain over motor nerve fibres of the brain and the spine to it. Each of the motor fibres is connected with 120 to 160 muscle fibres and is called a motor unit. When you move a muscle many such motor units " fire " electrically, putting their message on the record in the form of many up and down (diphasic) lines. If you think of moving the same muscle group without overtly moving it the electrical message will come soon, perhaps from one motor unit, then from more, and so on until the record is a mass of electrical lines. If somebody else moves the same muscle group for you (which is passive movement), the electric " dance " will be less than when you moved it yourself, and if you are very much relaxed while it is moved for you, the electric dance will be still

less or even absent because your "righting reflexes" in connection with that muscle group will then be less or absent. In a disease involving muscular weakness (myasthenia gravis) the diseased muscles give peculiar irregular electric messages of unequal strength. If we had room we could mention results of many more researches.

In the last few years another very promising phase of electrophysiology, which is tied up with psychology, has opened up. Dr Berger of Germany first published his results concerning this in 1929, which were later confirmed by Prof. Adrian. It is possible now for the first time in the history of science to pick up electrical pulsation from any intact human brain. These pulsations or beats (about 10 per second) are going on spontaneously in every brain and are modified more or less almost immediately by vision, hearing, touch, smell, concentrated attention, thought, images, emotional upset, sleep, slight muscular movement, hypnosis, etc. Some time ago I reported results which I obtained in connection with sleep. Brain potentials assume different patterns at different stages of sleep. In Iowa, Harvard and 10 or 12 other laboratories of the world fascinating investigations are going on along the brain potential line. Epileptics can be spotted out by their peculiar brain wave patterns long before they are medically diagnosed as such. To day researches are being made in the Boston City Hospital to locate brain tumors by this method. Problems of mental disease, mental deficiency, all sorts of psychological and biological problems are lending themselves to this type of investigation. Medically, biologically and psychologically brain and muscle potential work has a bright future. An advanced form of electrical recording for such purposes would be a great asset to scientific investigation in this country.

Our Automatic Breathing Control

For weeks even for months, the unborn child in the mother's womb makes distinct rhythmic respiratory movements, but these movements are not breathing, in that they do not expand the lungs and keep them expanded. If a lamb is delivered by Caesarean operation without disturbance of the placental circulation and is kept in a warm bath resembling its normal prenatal environment, the respiratory movements continue, but they still are not breathing.

The baby unborn and the fetal lamb maintained in conditions closely paralleling those before birth are both freed of the necessity of breathing. Once birth has occurred, however, if the creature is to survive, breathing must and does commence. What makes this difference?

Professor Yandell Henderson of the laboratory of applied physiology at Yale answered, in a paper read before the Connecticut Academy of Arts and Sciences, that a function deficient in the fetus is quickly developed at birth and then continuously maintained through life. Of critical importance for respiration, circulation and metabolism, this function is that of muscle tonus a condition of mild steady activity.

The inflation which normally exists in living lungs is a function of the tonus maintained in the respiratory muscles. From birth to death the lungs are never deflated, because the diaphragm is never completely relaxed.

At birth, tonus is induced in the muscles by the coming into action of the motor centres of the spinal cord. The relation of these centres to the presence of tonus is demonstrated by the fact that if spinal anesthesia reaches the motor neurones, a depression of tonus results, which produces in the body a diminution of respiratory metabolism, stagnation of the blood in the tissues, failure of the venous return to the heart, and relaxation of the respiratory muscles producing partial deflation of the lungs. The extreme form of this state, which may follow serious physical injuries and major surgical operations, is termed shock.

— *Technology Review.*

NOTES AND NEWS

Legacy of our Civilization to the Futurian of 6939 A. D.

Today with all our advance of knowledge how eager we are to read into the past to learn the life that existed on this planet of ours, say 5000 years ago, at Mohenjo-daro or at Babylonia or any other civilized place of those days. What has been spared from the all-swallowing bowels of time is often too inadequate to furnish any complete knowledge of the past. If the ancient man had only had the foresight—and the wherewithal to preserve an accurate record of his life and times, what a vast expansion of our cultural knowledge would be available to us to-day! That being not so, we have got to depend on archaeology for whatever it can do for us in that direction. But what was not done by the ancients for us, we can do, with our technical abilities, for the future civilizations.

It was with this end in view that Dr Thornwell Jacobs, President of the Oglethorpe University, proposed in the *Scientific American*, November, 1936, "to provide for future historians an epitome of the life of an old generation—a generation in which *we* lived," so that, "for the first time in the history of a civilized land, future historians will have available a thorough and accurate record preserved for them." The original proposal by Dr Jacobs has undergone several modifications, mainly in the matter of the date of this legacy to the future and the place of deposit of the record. It was finally decided that the world's first "Time Capsule" would be deposited at the bottom of a 50 foot "immortal well" beneath the rising walls of the Westinghouse Building at the New York World's Fair, 1939. "It has already begun its long journey into the future—a journey which, it is hoped, will extend through 5000 years of time," writes Mr D. S. Youngholm in the *Scientific American* of November, 1938.

The Time Capsule, as finally constructed, consists of an outer shell of Cupaloy, cast in sections, each to be threaded and screwed into the next and sealed with asphalt. The whole thing has been carefully planned and designed. The Capsule which is seven feet long and six and a half inches in diameter, includes more than 40 articles of common use in the present civilization, such as a fountain pen, a mechanical pencil, a watch, an electrical lamp, etc. All the rare objects of pride of our days will also be contained in it. Word will be left for future archaeologists in the form of a Book Record of very lasting materials, copies of which will be circulated all over the world with the expectation that some, which will survive, will give the required clue to the futurian for which it is meant. In case the futurian fails to follow the clue in determining the date of preservation, certain astronomical data, such as the number and dates of the solar and lunar eclipses of 1939, are given therein, as also the position of the planets and the angle of the Earth's Pole relative to the Star Polaris, which will be sufficient for them to calculate the time that will have then elapsed since 1939. Other matters of difficulty have been, as far as possible, obviated, and we all hope with the sponsors of the scheme that it will reach the proper hands 5000 years hence, and give the futurian an accurate estimate of the present-day civilization, feeling as we do that the good instincts of the human race will prevail in leaving it alone and undisturbed.

Rejuvenation by Sex Hormones

Experiments performed by Dr Neal E. Miller of the Yale University, on old men and on patients suffering from various types of glandular deficiency, revealed

that the injection with hormone testosterone propionate, unlike the one without hormone effected great and decided improvement in their conditions. Results showed that elation took place of depression, and rational aggressiveness that of irrational irritability, for some patients. Muscle tone, energy, and stamina returned, and, in short, the patients were in better condition both emotionally and sexually. Dr Miller gave out the results of his experiments with hormones, at a meeting of the American Chemical Society, and observed that old men could be rejuvenated both mentally and sexually by means of hormone injection.

Electrical Blanket for Babies

In this mechanical age of ours hardly does a day pass, which does not add something new to the already large number of the mechanical articles of convenience and comfort. Electricity has been of the greatest value in this direction. The latest electrical invention is a baby crib blanket which has the virtue of supplying sufficient heat under absolute control. The *Scientific American* has the following to say in this respect:

"......This blanket is fully automatic, in that it adapts itself to changing weather conditions during the night and maintains a pre-set temperature level. Despite the wiring contained in its double thickness, it can be laundered easily and it is shock proof when wet. It is connected to the ordinary household circuit of 115 volts but a transformer reduces this voltage to 18, a voltage which is not even strong enough to provide a tingling sensation when passed through any part of the body."

The Largest Geological Globe at Kensington

The largest terrestrial globe of the world which shows both orographical detail and the distribution of the main geological formations, was formally installed in the Geological Museum at South Kensington on October 10 last by Sir Frank Smith, Secretary of the Department of Scientific and Industrial Research. It consists of a sphere of fibrous plaster, 5 ft. 11 in. in diameter. "Six distinct colours are used to indicate the sedimentary deposits of the Geological eras, and the systems formed during each era are distinguished by graduated shades of the appropriate colour; the lightest shade represents the newest system, the darkest represents the oldest. Igneous rocks appear in scarlet and orange; and ice-caps, rivers and lakes are also marked." (*Nature*). The axis of the globe is inclined at an angle of $23\frac{1}{2}°$ to the vertical. There is an electrical mechanism by which the globe can be made to rotate about itself at the rate of one revolution in $2\frac{1}{2}$ minutes.

Proposal for a College of Pharmacy in Calcutta

Pharmacy is an essential public service, and an integral part of the noble profession of medicine. But unfortunately for us in India, it is in a very chaotic and neglected state today. The Drugs Enquiry Committee, appointed by the Government of India some eight years ago, reported that the profession of pharmacy in this country was in a very deplorable condition, compared with almost all other civilized parts of the world. Recently at the Third Annual Conference of the Bengal Pharmaceutical Association, Col. Chopra, who presided, reiterated the same thing in his address. There is no doubt that there is an urgent need today of organizing the profession of pharmacy in our country and bringing it up to the level of pharmaceutical practice found elsewhere. There is no institution at present where adequate training in pharmaceutical chemistry and manufacturing pharmacy is available. The establishment of such an institution, will, we believe, go a long way towards the uplift of the profession.

It was therefore quite in the fitness of things that Dr D. E. Anklesaria of Ahmedabad, made a proposal to the Government of Bengal towards the establishment of a college of pharmacy in Calcutta, expressing his readiness to donate Rs. 200,000 for the purpose, provided that the Government of Bengal contributed an equal sum for construction of a building and laboratory on a suitable land to be given free by the Government. The other conditions of Dr Anklesaria's proposal are that the Government should equip the laboratory with modern pharmaceutical apparatus and plant, that it should bear all the recurring expenses of the college, and that the entire teaching staff should consist of Indians, with the exception of the principal and the professor of pharmaceutics, pharmacology and pharmaceutical chemistry so long as properly qualified Indians for these posts are not available. The course, as proposed, should be of three or four years after matriculation. The College should grant a deploma in pharmacy, a degree of Bachelor of Pharmacy being granted by the Calcutta University. The Government of Bengal should further enact that no chemist and druggists' shop can be conducted except by a qualified chemist.

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Following this magnanimous proposal by Dr Anklesaria, the Government of Bengal is seriously considering the advisability of starting a college of pharmacy, and they have set up a committee of experts to investigate into the matter. The Committee consists of (1) Brevet Colonel R. N. Chopra, (2) Prof. B. N. Ghosh, (3) Mr J. L. Bell, (4) Dr B. Mukerji, (5) Dr Jitendra Chandra Aich, (6) Sir Upendra Nath Brahmachari and (7) One member to be nominated by Calcutta University.

The Committee will be required to report on the syllabus and course of study and the staff that would be necessary; on the total expenditure involved in the proposal; and the necessity and feasibility of legislation with a view to ensuring that only qualified pharmaceutical chemist should conduct chemists' and druggist' business. We hope that there will be little in the findings of the Committee which may prevent the establishment of a college of pharmacy, which, when opened, will remove a long-felt want of this province, and will also throw open new avenues of employment for the educated youths of this country, especially of Bengal.

The Indian Journal of Pharmacy

The United Provinces Pharmaceutical Association was started in 1935 with the objects, among others, of promoting "the cause of the science and art of pharmacy in all their different branches," and to give adequate training for the profession of pharmacy in U. P. Another object of the Association is to edit and publish such journals and books which will promote the cause of pharmacy in India. It is now announced, we are glad to learn, that arrangements are now complete for bringing out a quarterly journal from Benares, the present headquarters of the Association, under the title, The Indian Journal of Pharmacy, from January next. An editorial board has been formed and it will consist of (1) Prof. M. L. Schroff, as Chief Editor, and Messrs (2) B. B. Bhatia, (3) S. S. Joshi, (4) K. C. Pandya, (5) S. K. Sen, (6)* S. K. Chaudhuri, (7) P. S. Varma, (8) G. P. Srivastava, and (9) B. P. Dube. The annual subscription has been fixed at Rs. 3/ (inland) and 6*s* (foreign). The members of the Association will, however, get it free of charge. We shall be eagerly looking for the first issue of the Journal.

The Seventh All-India Industrial Exhibition

For the last few years Delhi has been holding every year an important Industrial Exhibition under the auspices of the Association for the Development of Swadeshi Industries, and preparations for the seventh one, we learn, are now complete and will be held in the last week of February 1939, at the Peoples' Park, as usual, near Red Fort. Only *Swadeshi* products will be exhibited and sold in the exhibition excepting the foreign industrial machinery. The Exhibition plan, prospectus and any further information in connexion to the Exhibition, can be had from the Hony. Secretary of the Association, Chandni Chowk, Delhi.

Second Session of Indian History Congress

The Second Session of the Indian History Congress held last October at Allahabad has been described as a huge success. Several important resolutions were passed by the Congress at this session, and reference has already been made in our editorial article of this month at some great length to the one by Dr S. Krishnaswamy Iyengar which urged "that a Committee be appointed to examine the feasibility of preparing a scientific and comprehensive history for India with instructions to report at the next session of the Congress." Our leading article in this issue discusses the Resolution, and our comments have been made therein. There was some controversy over the word "feasibility" in the Resolution, which was finally adopted in its entirety, and a committee of the under mentioned persons, with powers to co-opt, was constituted for the purpose.

Dr D. R. Bhandarkar, Sir Jadunath Sarkar, Diwan Bahadur Dr S. Krishnaswamy Iyengar, Rao Bahadur K. N. Dikshit, Prof. Md. Habib, Rao Sahib C. S. Srinivasachari, Prof. K. A. Nilkantha Sastri, Prof. D. V. Potdar, Dr M. H. Krishna, Dr Surendra Nath Sen, Dr Balkrishna, Sri Jayachandra Vidyalankar, Prof. Sri Ram Sharma, Sir Shafaat Ahmad Khan, Mr R. V. Poduval and Mr B. V. Krishna Rao.

Another resolution adopted by the Congress runs as follows:

The Indian History Congress is strongly of the opinion that well equipped record offices should be established by all the provincial Governments and Indian States at an early date to facilitate historical research. The Congress considers it essential that

adequate facilities should be afforded to all *bona fide* scholars of history in such offices."

The resolution was moved by Dr Balkrishna and seconded by Dr Sir Shafaat Ahmad Khan.

Preservation of Historical Treasures

In connexion with the Peace Pact inaugurated by Dr Nicholas Roerich, the well-known painting artist, which aimed at the preservation of historical arts and treasures bearing evidence of the different stages of culture the world has passed through, from the dark stages of history, the History Congress next adopted a very important resolution moved by Dr Tarachand of the Allahabad University. Cases of vandalism have by no means been uncommon in the past, and the recent happenings in Spain definitely point to the urgent need of such a pact. It has already been adopted by twenty one countries and a large number of learned societies and cultural associations have voluntarily bound themselves in honour to protect the historial treasures, the saving of which from the hands of war hooligans is essential for the development and progress of culture. The resolution passed by the Congress reads as follows:

Resolved that the second Indian History Congress, held at Allahabad, approves of the International Pact for the protection of artistic and scientific institutions, historic monuments, missions, and collections, originated by Nicholas Roerich and records its support of the three Articles detailed below:

Article I—The historic monuments, museums, scientific, artistic, educational and cultural institutions shall be considered as neutral and as such respected and protected by belligerants. The same respect and protection shall be due to the personnel of the institutions mentioned above. The same respect and protection shall be accorded to the historic monuments, museums, scientific, artistic, educational and cultural institutions, in time of peace as well as in war.

Article II—The neutrality of, protection and respect due to, the monuments and institutions in the preceding Article, shall be recognized in the entire expanse of the territories subject to the sovereignty of each of the signatory and acceding states, without any discrimination as to the state allegiance of the said monuments and institutions. The respective Governments agree to adopt the measures of internal legislation necessary to ensure the said protection and respect.

Article III—In order to identify the monuments and institutions mentioned in Article I, use may be made of a distinctive flag (red circle with a triple red sphere in the circle, on a white background.)

The next session of the Congress will be held at Calcutta.

"The Radium Hound"

Radium, as is well known, is a precious stuff. It is used in the treatment of cancer and some other diseases, and the amount used in such cases is so small that it stands the risk of being lost, as the patients can hardly realize the immense cost of the product. But the amount, when lost, may be in some cases recovered with the help of what is named the "radium hound" which is nothing but the electroscope or the Geiger-Muller counter, both of which are affected by the gamma radiation emitted by radium. The radiation counters are so sensitive that whole house can be searched for radium from the outside in cases of suspected theft. Radium causes severe burns if it is kept near an unshielded person, and the "radium hound" gives reassurance that the lost radium is not located where it will cause harm. We have it on the authority of the *Scientific Monthly* of October 1938 that Dr Robert B. Taft of Charleston, S.C., has compiled stories and statistics of radium theft and its recovery. Out of 107 records of losses, there are 59 complete and 11 partial recoveries. The most interesting case is the one in which the lost radium was recovered from the stomach of a pig, who devoured it along with the refuse of the hospital from which it had been lost.

An Electrodeposition Exhibit

The general public is quite familiar with many of the applications of electroplating today. Silver plated and chromium plated articles, for example, are well known. It is not, however, generally realized to what an important extent other electrodeposition processes contribute to the amenities of modern life. In the production of gramophone records, and in the photogravure process used for printing postage stamps and pictures, electrodeposition is a vital process. It also constitutes an important stage in the production of Treasury notes, and is used at the Royal Mint to form the steel dies employed in striking coins and

medals. Many of the modern coloured finishes which are being increasingly used, both on small articles and on large panels for interior decoration, are produced on aluminium and its alloys by an electrolytic process. Electrodeposition, again, is used to protect metals against wear and corrosion, and as a method of repairing worn or undersized machine parts. These and many other examples of the varied applications of electrodeposition were on view at a special exhibition held at the Science Museum, South Kensington, London, in 1935. The success of this exhibition has prompted the arrangement of a smaller permanent exhibit, which has been generously presented by the Electrodepositors' Technical Society. With some ingenuity the main features of the original exhibition, which occupied a floor space of 4,000 sq. ft., have been incorporated in a single case. This is now on view in the Chemistry Collections of the Science Museum. One of the most interesting section of the exhibit deals with research, and has been arranged by the Research Department, Woolwich. Here may be seen the results of the systematic studies of electrodeposition problems made at Woolwich and elsewhere during the past twenty years.

Profssor C. G. Darwin

Professor C. G. Darwin, F.R.S., has been appointed Director of the National Physical Laboratory in place of D. R. R. Fowler who has resigned for reasons of ill-health. Dr Darwin is well known for his work in mathematical physics.

Khan Bahadur Afzal Hussain

Khan Bahadur M. Afzal Hussain, Principal, Agricultural College, Lyallpur, Punjab, has been appointed Vice-chancellor of the Punjab University.

Profssor A. Jha

Professor Amaranatha Jha has been elected Vice-chancellor of the University of Allahabad at the annual meeting of the University Court on November 17 last. Professor Jha had been officiating as the Vice chancellor since July last, when his predecessor Dr Iqbal Narain Gurtu resigned. Formerly Mr Jha occupied the chair in English at Allahabad.

Dr G. Stafford Whitby

The Lord President of the Council has appointed Dr G. Stafford Whitby, at present Director of the Division of Chemistry, National Research Council, Canada, and formerly Professor of Chemistry at the McGill University, Montreal, to be Director of the Chemical Research Laboratory, Teddington, in succession to Sir Gilbert Morgan, F. R. S., who retired on 30th September last. Dr Whitby is expected to take up his duties early in 1939.

Errata

In Vol. IV No. 5, p. 281, para. 4, l. 4 *read* bank and 840 yards *for* bank and 810 yards.

SCIENCE IN INDUSTRY

Measurement of the Resistance of Liquids

In many industries the specific conductivity, *i.e.*, the reciprocal of the specific resistance, of liquids must be regularly checked. This may be so in the case of the waste water, the boiler water and the rinsing water in laundries where the progress of the washing process must be determined. In the sugar technique also it is simpler, instead of the elaborate determination of the ash of the sugar, to measure the specific resistance of the sugar solution which is directly connected with the desired weight of ash. It is, however, impossible to measure the resistance of a liquid with direct current as may be done with a metal conductor because of the development of polarization voltages between the electrodes. But the influence of the polarization may be obviated by measuring the resistance in a suitably constructed vessel with an alternating current of sufficiently high frequency.

Mr A. Claassen describes (*Philips Tech. Rev.*, 3, 183, 1938) an arrangement for the measurement of the specific resistance in which he has made the problem simple.

It consists of:

(1) the 'Philoscope' universal measuring bridge type GM 4140,

(2) a generator for 1000 cycles: GM 4260, offering the possibility of choosing between a frequency equal to the mains frequency and a constant high frequency of 1000 cycles independent of the mains frequency for supplying the bridge part of the measuring bridge, and

(3) the measuring vessel GM 4221. This vessel is constructed as an immersion cell. The platinum electrodes, each with a surface of about 1 cm square, are placed vertically at a distance of about 8 mm from each other and joined to the copper leads by means of platinum wires fused into the glass. The copper leads in turn make contact with the terminals. The outer surfaces of the electrodes are entirely covered with glass which has been applied in the molten state, and are held rigidly in place by a glass support. The electrodes are completely protected by the robust outer glass jacket of the measuring cell. This outer jacket has openings at the bottom and at the side to make it easier to fill it with the liquid. An expedient which has been found useful for the practical avoidance of polarization in the case of solutions of low specific resistance, lower than 1,000 ohm cm, is the platinizing of the electrodes.

It has been found possible with this arrangement to carry out accurate measurements in the range extending from solutions with a specific resistance of about 20 ohm cm to solutions with the highest specific resistance occurring (several hundred thousand ohms cm). In solutions having specific resistance less than 20 ohms the influence of polarization may persist. It is possible, in that case, without using very much larger platinum electrodes or by making the distance between the electrodes very great, to take into account the influence of polarization, which is manifested in a decrease of the cell constant (10-15%) by calibrating the cell with solutions of very low specific resistance, as for example sulphuric acid of maximum conductivity (sp. resist. 1.3 ohm cm) or a saturated solution of sodium chloride (sp. resist .5 ohm cm). If the absolute value of the conductivity in this range is of less importance, relative

measurements of great accuracy are always possible. In the measurement of the conductivity of poorly conducting solutions it is necessary to take account of the conductivity of the water used and since the influence of the temperature on the specific resistance of liquids is very great, an accurate measurement of the temperature within 0.2° C is necessary for precise determination of specific resistance.

Sericultural Conference

A very important conference of sericulture took place in the third week of November with Mr F. I. Rahimtollah, President of the Tariff Board in the chair. The Conference was fully representative of the whole of India and was attended by the Directors of Industries of the various provinces interested in the industry, besides other important officials. Sericulture forms an important industry of the country, and there is yet ample room for developing it. Besides indigenous production of some 20,00,000 lbs. of raw silk India consumes 25,000,000 lbs. more which is imported from foreign countries, such as China and Japan. It is held by authorities on the subject that the whole of the country's requirements can be supplied by the Indian industry, provided adequate protection is given to it by the Government.

It is suggested that the Imperial Sericultural Institute should devote greater attention to the question of research and have the power to review the sericultural work done in the various provinces and States during the year, decide a programme of development work for the future, coordinate the work of the various provinces and States, and lay down lines of research work to be done, the results of which are to be made available to the whole of India.

The provincial representatives stated that since provincial autonomy had been introduced, the Ministers had taken much interest in cottage industries and were taking steps to safe-guard the interests of handloom weavers. So far as silk weaving was concerned, however, it was not receiving the same attention as cotton and wool. Mr Green, Director of Industries, Madras, suggested that the Central Government should assist the silk weaving industry in the same way as they were now doing in regard to the cotton industry, namely by a subvention.

Cost of the Manufacture of Synthetic Ammonia

In his article entitled "The manufacture of synthetic ammonia and nitrogenous fertilizers" published in the September 1938 issue of SCIENCE AND CULTURE, (pages 178-182), Dr N. G. Chatterji gave an estimate of the cost of production of synthetic ammonia, based on the information available at that time, chiefly from that of an exhaustive estimate made in 1926 by Prof. Tour of America who was in charge of a large synthetic ammonia factory in that country. The author has recently received more information regarding the latest type of plant . The following revised estimate of the cost of production of synthetic ammonia, has now been worked out by Dr Chatterji with great care and can therefore be confidently put forward as being fairly reliable for drawing up scheme by National Planning Committee.

Capacity of the Plant. The minimum capacity of the plant recommended by experts from different countries is about 20 tons of combined nitrogen or 24 tons of ammonia per 24 hours, or 7,200 tons per year of 300 working days. The estimates are therefore for a 24 ton per day ammonia plant.

PLANT COSTS

1. *Ammonia Section*		..	Rs. 22.5 lakhs
(a) Water gas plant, purifier, Hydrogen conversion plant, CO_2 and CO washers &c.	6.8 lakhs.		
(b) Ammonia synthesis plant, Gas holders, &c.	11.2 lakhs.		
(c) Erection charges	1.6 ,,		
(d) Building charges	2.9 ,,		
Total	22.5 ,,		
2. *Power Section*	..	.. ,,	3.5 ,,
Total physical plant costs			Rs. 26.0 lakh
3. Overhead costs (during construction)		,,	3.0 ,,
Total plant costs			Rs. 29.0 lakhs

Capital investment.

On plant	Rs. 29.00 lakhs.
Working capital	„ 7.00 „
Total capital investment	Rs. 36.00 lakhs.

Fixed charges.

1. *On plant.*

Depreciation @ 7½ on Rs. 29.0 lakhs. Rs. 2.175 lakhs.

2. *On invested capital.*

Interest, taxes, insurance, &c. @ 7% on Rs. 35.0 lakhs. Rs. 2.450 lakhs.

Total fixed charges Rs. 4.625 lakhs.

Hence, per ton of ammonia Rs. 64.

AMMONIA PRODUCTION COSTS.

Raw materials costs.

(per 24 tons of ammonia)

Electric energy, 42.200 K.W.H. @ 3 pies per unit.	Rs. 660
Coke, 33 tons @ Rs. 8/- per ton. ..	„ 264
Steam, 50 tons @ Rs. 1.20 ton. ..	„ 60
Cooling water, 625,000 gallons; Feed water, 14,000 gallons ..	„ 18
Gas purifying mass, catalyser, chemicals, &c.	„ 152
Total	Rs. 1,154

Or per ton of ammonia .. Rs. 48

Hence,

	Per ton of ammonia.
1. Raw Materials and Energy ..	Rs. 48
2. General plant expense	„ 17
3. Running maintenance	„ 32
4. Overheads, contingency &c. ..	„ 21
Total operating costs ..	Rs. 118
Total fixed charges	64
Total production costs ..	Rs. 182

Hence, for a plant of capacity, 24 tons per day.

Total production cost of synthetic ammonia is estimated to be about Rs. 182. per ton.

New Post of Director of Dairy Research in India

Following the recommendation by Dr N. C. Wright in his report on the cattle and dairy industries of India to establish a Central Dairy Research Institute, the Central Government who have accepted it in principle have come to the conclusion that as paucity of funds will not allow the setting up of such an institution, the appointment of an expert coordinating authority need not on that account be delayed. Applications have therefore been invited for the post of the Director of Dairy Research. It is stated that the appointment will be made towards the end of this year.

This officer will be instructed to devise schemes for the improvement of dairying generally in India and his expert knowledge will be at the disposal of any provincial Government desiring his assistance. He will also study the position in regard to the Central Institute, and Government do not propose to come to any decision as to its location or equipment until his advice has been received.

The majority of recommendations made by Dr. N. C. Wright about his survey of India's cattle and dairy industries problems call for action by the provincial Governments, and the Central Government in a recent communication to the provinces stated the importance of the utmost cooperation and coordination in the work done. In this connexion it has been shown that much time and energy might be wasted by duplication of experiments. Great importance is attached to the encouragement of mixed farming. This is also a matter for the provincial Governments but it is understood that the Imperial Council of Agricultural Research are prepared to make small grants to the Governments for experimental purposes and that the Government of India have under consideration the adoption of mixed farming experiments at Delhi and Karnal. Schemes of research on pasture improvement are also being considered by the Imperial Council of Agricultural Research. The Central Government have under consideration the possibility of holding a combined Cattle and Dairy Conference towards the end of next year when the progress made on Dr Wright's report will be reviewed and fresh schemes for the promotion of the industry will be examined.

Survey of Industrial Possibilities

We have several times in these columns urged upon the desirability of setting up a committee consisting of

specialists and experts for planning on a comprehensive scale a scheme of country-wide industrialisation for India. We are firmly convinced that without an efficient plan of national industrialisation India could neither raise her standard of living which is now so low nor could she attempt to solve properly the acute problem of unemployment. It is, therefore, just and proper that the Indian National Congress has recently appointed a National Planning Committee, which would devise ways and means to tackle the country's problem of national reconstruction, and the personnel of the committee is both strong and inspiring. It consists of Pandit Jawaharlal Nehru as President and Sir M. Visvesvaraya, Professor M. N. Saha, Sir Purushuttomdas Thakurdas, Mr Ambalal Sarabhai, Professor K. T. Shah, Dr Nazir Ahmed, Mr A. D. Schroff, Mr A. K. Shaha, Professor V. S. Dube and Prof. J. C. Ghosh with a non member secretary to be furnished by the Government of Bombay.

The findings of the Committee will be presented before a National Planning Commission consisting of Ministers of Industries of the Congress provinces and also of other provinces and the States co-operating for the execution of the plan together with four representatives of commercial bodies and one representing the All-India Village Industries Association. The members of the Committee will be ex-officio members of the Commission.

Bengal, which is not a Congress province, has not lagged behind and, we are glad to announce, has set up a committeee of its own for similar purposes. It has a strong personnel consisting of Dr John Matthai, Director General of Commercial Intelligence and Statistics as chairman and Dr J. P. Neyogi, Minto Professor of Economics, Calcutta University, Dr J. C. Ghosh, Professor of Chemistry, Dacca University, Dr S. K. Mitra, Ghose Professor Physics, Calcutta University, Dr N. N. Law, Mr M. A. Ishpahani, Mr Rajsekhar Bose, Mr B. M. Birla, Mr S. C. Mitter, Director of Industries (ex-officio) with Mr J. N. Sen Gupta, Secretary of the Bengal National Chamber of Commerce as secretary of the Committee.

Terms of reference of the Bengal Committee have recently been announced and they are, as will be found from the text given below that they cover practically the whole field.

(*i*) To examine the position of the existing large and medium sized industries in the province showing (*a*) which industries have reached a stage of full development and (*b*) which of them still hold out possibilities of further expansion and (*c*) in which directions there are still possibilities for the establishment and development of such new industries with a fair prospect of success.

(*ii*) To enquire into the difficulties and problems that confront the existing important large and medium-sized industries of the province and suggest measures for the improvement of their conditions.

(*iii*) To examine the location of existing industries and of industrial resources of the various divisions of the province and suggest means for securing the utmost diversification and the best geographical distribution of industrial activities throughout the province.

(*iv*) To advise what industries subsidiary to large scale industries have a fair prospect of success in this province and how far and by what methods such industries can be developed within the province.

(*v*) To advise on the measures which the Government can undertake to promote and develop large scale and medium sized industries within the province and, in particular to draw up a plan for the establishment and development of industries of national or economic importance including " Key " industries.

(*vi*) To examine the present position and working of small and cottage industries including those which are in the nature of a hereditary calling of any class or caste with special reference to:

(*a*) sources and terms of supply of raw materials;

(*b*) credit and financial facilities;

(*c*) marketing;

(*d*) improvement of productive technique.

(*A*) Recommendation should be made as how (*a*) may be improved and facilities as to (*b*), (*c*) and (*d*) may be provided.

(*B*) Recommendations should also be made about such of the cottage industries as are in a moribund condition with a view to effect their rehabilitation.

(*C*) To advise as to the possibility of starting new cottage and small industries in the villages.

(*vii*) To enquire and assess the results achieved by the various measures instituted by the Industries Department for the last 17 years and advise how far these measures have been actually effective in developing industries and how far they hold out material prospects for such development, and which of the measures should be discarded as of little or no practical value and what new steps should be taken to further the object in view.

(*viii*) And finally to make such other recommendations as pertain to State policy with regard to industrial development within the province.

We do hope that there will be ample grounds for co-operation between the National Planning Committee and the Bengal Committee, whose report on provincial resources should be a valuable asset in the deliberations of the National Planning Commission at a later date.

Scientific Research and State Aid for the Development of Industries in India

S. S. Bhatnagar
Director, University Chemical Laboratories, Lahore

We can see to-day the dim lights of a new dawn in the distant horizon of Indian progress. These faint radiations are not the vanishing streaks of our glorious past; they are the sure signs of a new birth full of promise and glory for the future. This dawn represents the birth of the Industrial Movement in India. The movement has been rather delayed, though its genesis could be traced to the years even before the War. The events of the War, however, gave a great impetus to the development of indigenous industries. Even the Government, whose lukewarm interest in industry had become proverbial, realized the importance of industrial expansion of India and we note that the Indian Industrial Commission appointed during the years 1916-1918 reported "that the experience of the War itself has been responsible for a new attitude on the part of both Government and leading industrialists. They realize that it is necessary to create in India the manufactures that are indispensable for industrial self-sufficiency and for national defence and that it is no longer possible to rely on free importation of essential articles in time of War."

The successes of the textile industry and the sugar industry furnish illustrations of the fact that, given adequate facilities, Indians are capable of handling big businesses intelligently and efficiently. Not only are these two industries in a flourishing state, but the electrical companies and the woollen industry, besides many others, have also done good business. These examples further bring home the fact that all Governments can really stimulate industries by the granting of subsidies, and loans from official banking institutions or by the imposition of protective tariffs. The Indian industrialists should not be slow to realize that the secret of success in this or any other industry lies in the economic utilization of all the bye-products of an industry and that this can be achieved only by contact with the uptodate methods and application of science. The businessman, proud of the initial success in a new undertaking, is apt to become a slave of tradition and the rule of thumb, and often begins to look with scorn upon scientific discoveries which he contemptuously calls 'theories.' An example of this may be found in the pre-War history of the British Industry. There was practically no intercourse and no co-operation between the men of science of that country and the leaders of industry. There were, here and there, a few enlightened industrialists who were interested in applying the methods of scientific research, but it became a reproach to British industry as a whole that it ran only in well-established grooves and refused to adapt its products to the requirements of the time, with the result that the continental products, particularly the German articles, gradually ousted the British goods from the market. This achievement of

the Germans was no doubt due to the recognition by their Government and industrialists of the need of active cooperation between the men of science and industries, which led to the introduction of many new processes in industry and to the extensive employment in Germany of scientifically trained men for industrial research.

British industrialists as a body paid no heed to these warnings and reproaches and rarely called in the aid of science and scientific workers. When, however, the war of 1914 came with all its imperious and multi farious demands for greater production and better articles than already available or for suitable substitutes for materials the supply of which was diminished or cut off, there was a sudden awakening and an imme diate change of attitude which has been maintained ever since. Now that Europe is on the threshold of another war, the need for cooperation between science and industry has become increasingly apparent, parti cularly in countries which love peace but maintain that a strong preparation for defence is the surest guarantee for peace. Not only England but India also has felt the necessity of such a cooperation. It is reported that a Government Committee has been set up with a view to study the subject of air-raid precaution necessary for the defence of the towns of India and her civil population. It is also considered necessary that the provincial govern ments and local authorities should be instructed in good time in the arrangement to be undertaken, if India is to be prepared to meet a danger which undoubtedly exists. But the industrialists in India are far too slow in recognizing the need of an active programme of industrial expansion in this country which should manu facture not only the principal articles of every day use in times of peace but also war materials and munitions which cannot be imported easily owing to the exigencies of a coming war which threatens to put an end to modern civilization. There is no doubt that there is some awakening in firms which belong to Tatas, Birlas, and Lala Shri Ram, but it is not commensurate with the gravity of the present world situation with its terrific roll of unemployment and the misery of the farmers owing to a fall in the prices of agricultural goods. Even the industries which are considered to be flourishing are not free from danger. Take, for instance, the much-talked of sugar industry. It is obvious that success in this or any other similar industry would lie in the economic utilization of its bye products. Yet, how many sugar manufacturers are there who have seriously given thought to the problems of molasses or bagasse? It remains to be seen whether Indian industrialists would come forward and help in developing schemes which have been suggested by the Joint-Committee of the U. P. and The Bihar Governments for the utilization of molasses. The advantages which the sugar manufacturer now enjoys might disappear or science may so revolutionize the production of sugar that even the protection which he now enjoys may not be able to help him. The only thing which can save him when the real competition comes will be, the subsidiary industries which he develops, and it is therefore necessary that he should lay aside a part of his income for researches into the economic utilization of the bye products, for the improvements in the breed of sugarcane and soil and for the technical procedures involved in sugar production. A small permanent profit is more useful than a windfall for a few years and it can be achieved only a complete *entete cordiale* between the technical staff, the labour and the capitalist. The present practice of paying off the technical staff when the season is off and re employing it when the crushing of the cane re starts reduces the status of the technical staff to that of a daily wages and kills all initiative for hard and honest work. A distressing feature of the industry, particularly in the Punjab, is that relationship to the directors and external influences are becoming more increasingly a passport to employment than talent, even in technical jobs.*

There are several causes which are responsible for this lack of coordinated efforts for a rapid industrializa tion of our country. Of these perhaps the most out standing one is the attitude of the capitalist, who seems to be imbued with only one desire, namely that of making money.

Yet, the present slow pace of industrial progress is not entirely due to the capitalist. Whatever little in the shape of industries exists in India is due to the enterprise of the British businessmen and the Indian capitalist. There were and there are still in India investigators in pure science who not only carry on their work without any thought of the possible utilization of their results in industry or in everyday life but go so far as to say that science would be degraded by having its discoveries put to such a base use. The science

* This equally applies to the textile and other Indian industries, perhaps not yet in so flourishing a state as the sugar industry.

teaching in the universities and colleges was therefore planned to give students a mere theoretical smattering of these subjects. The Indian industrialists were therefore justified in looking upon our graduates as unfit for technical employment in industry. Things are, however, fast changing and the modern young student of science realizes that while fundamental theoretical work must continue to be the basis of all scientific advance his subject would lose all its importance if this training did not fit him for tackling large scale problems which arise in industries. Several Indian universities have now instituted courses of studies for technical chemistry in their university curricula. The Punjab University was one of the first in the field and the success of industrial research in the university has more than justified the experiment. Besides Lahore, there exist in Calcutta, Benares, Bombay and Nagpur facilities for meeting the demands of some of our successful industries and the industrialists would do well in giving these institutions a chance to show what they can do in the matter of industrial researches. There is, however, a great deal yet to be done in the Indian universities in that direction. The courses of studies themselves require careful recasting not only at the university but at the school stage more particularly.

Let us illustrate this need further. The trees flower and bear fruit, the sun shines, the clouds appear and it rains, the wind blows, a rainbow is seen, the thermometer rises, water boils and becomes hot or cold, the moon waxes and wanes, a boy wears glasses, the smoke rises into the chimney, the polished floor is slippery and some colours get fainter on washing or in the sun. How many children are taught the meanings, the causes or effects of any of these happenings? One may be certain that a grasp of these phenomena would do more to foster a truly scientific spirit and understanding than all the texts drilled into the aching heads of our young children.

It is to be hoped that the responsible government now introduced in the land would do something in this important matter, for it is perfectly useless to build up an edifice of glory in the shape of a high university education on so slender a foundation as our school curricula provide at present. Those who are familiar with the education of children in American, British and continental schools would appreciate the significance of the above remarks. The general knowledge of a young child in Europe is far superior to that of a school boy in India, even of a higher age. This state of affairs points to the urgent need of a complete overhaul of our system of education in the infant and primary classes, as without a proper foundation it would not be possible to get the maximum benefit of the higher education which is comparatively better organized in our country.

It is only proper that the Indian industry, which has not as yet risen to such heights of prosperity as to maintain a separate industrial research organization of its own, should harness to its advantage the services of some of our distinguished university professors and the excellently equipped laboratories which the colleges and the universities have at their disposal. It is to be regretted that amongst so many of the scientific workers at university research centres only a noted few realize the vital necessity of industrial research. This apathy may, however, to a great extent, be due to the industry itself which is unaware of the facilities and talents for research which exist in this country. This state of affairs has been brought about by a lack of contact between the heads of the university research laboratories and the leaders of industry. Every go-ahead industrialist should know what type of equipment and facilities exist in the various departments of different universities so that he may know as to which centre is best suited to help him in a particular requirement of his.

It has been alleged that the Indian chemists have done little to help industry. While this complaint may have been justified ten years ago, it is not so now and the capitalist has just to look round and he will find that the country has several promising industrial researches which await exploitation. Without making any invidious distinctions, I may mention the excellent work which has been done to revive the Lac Industry by my friend Dr H. K. Sen of the Lac Research Institute, Namkum, Ranchi. Lac and lac dyes have been known and used in India from very ancient times, but it is only since the beginning of this century that its economic importance was realized. With the advent of synthetic dyes, lac dyes for which lac was initially prized was forgotten, but the resin occupied the important position which it now does. In numerous industries, lac plays its part, in most instances, however, only in small proportions, the aggregate of which is very considerable. An idea of it may be had from the per

centage consumption of the total lac in the various big industries—gramophone records (35-40%), electrical insulation (15-20%), paint and varnish industry (15%), hat stiffening (10%), sealing wax (5%), lacquering, grinding wheels, etc. (the rest). The consumption of shellac was confined till lately to the highly industrialized countries of Europe and America, but recently Japan and Russia have been importing large quantities of the resin. India and Burma account for 95% of the world's production of shellac, and yet less than 3% is utilized in the country of its origin. The production has kept pace with the demand, and the capacity to meet steady increased requirements seems well-nigh unlimited. The exports of shellac have increased from 2,000 tons in 1868 to 10,000 in 1900 and 35,000 in 1936. Roughly, one part of shellac is produced from 2 parts of raw lac, called scraped lac or stick lac.

The lac industry of India has to grapple successfully with the synthetic resins; otherwise it will be wiped out exactly in the manner in which the indigo industry has been. Research work should be directed towards introducing those qualities in shellac by chemical and physical means which make bakelite the superior product.

A very important outlet for shellac is in the French polish industry, but it consumes something like 15% of the total output of shellac only. Consequently a more suitable line of consumption for shellac is being sought in the building industry. Paints with shellac and boiled oils have already been investigated, which promise fair to be capable of being used as cement floor paints, distempers, etc. An interesting diversion of shellac has been proposed by its being condensed with linseed oil acids in the presence of glycerine and suitable catalysts. This work is in progress still, and its successful conclusion is being looked forward to.

The gramophone industry which is the largest consumer (about 40% of the total shellac) of shellac is now being constantly offered synthetic resins for their record-making, but as yet none has been found of quality and price to be able to replace shellac. Intensive research is necessary to retain this monopoly market for shellac, and efforts at Namkum are being directed to this end with a view to lay the foundation of a sound record industry in India. In the same line, the moulding of every-day articles out of shellac is being investigated, with the result that already passable samples of containers for cigarettes, powder box, pin trays, shaving soap boxes, etc. have been produced at the Namkum Institute at costs very much lower than those of synthetic made commodities. Assemblage af proper machines and moulds are now under progress with the hope that an entirely Indian moulding industry on India's own raw materials may be realized.

At the Forest Research Institute, Dehra Dun, a considerable amount of very useful work is being done which can give rise to scores of useful industries in India. The Ascu Process of Mr Kamesam which consists in fixing arsenic and copper in wood by the agency of a chromium salt has been extensively employed and has given rise to a wood preservation industry in India. Mr Bhargava, the paper expert, has devised interesting ways and means of getting cellotax boards out of bagasse, a waste product in bigger sugar works. Dr S. Krishna's researches on Ephedra at the Forest Research Institute helped Baluchistan in organizing the trade in this drug and his work on the isolation of vegetable tallows is of particular interest. This term was originally applied to the solid fat from the fruit of Chinese tree, Stillingia sebifera (Syn. *Sapium sebiferum Roxb.*) on account of its resemblance to tallow and its successful use in candle making and for sizing of cloth. This definition has since been extended and now includes vegetable fats that possess certain chemical and physical characteristics.

The principal Indian vegetable tallows of trade are: (*a*) Mowra tallow (*Bassia butyracea* and allied species.) (*b*) Piney tallow (*Vateria indica*), (*c*) Borneo tallow or Sal butter (*Shorea robusta*), (*d*) Garcinia tallow (*Garcinia spp.*), (*e*) Chinese vegetable tallow (*Sapium sebriferum*).

The physical constants of these vegetable products are so akin to the animal tallows that they must capture the market owing to their cheaper cost of production and the businessmen interested in it ought to pay a visit to the Forest Research Institute.

Most of the above mentioned vegetable fats have a pale colour which gradually gets bleached on standing and more readily if exposed to sunlight. The specific gravity and refractive index values for the vegetable fats have been calculated from the existing data to what they would be at 15°C. for sp. gr. and at 60°C. for refractive index.

Properties of a good sizing tallow:

(*a*) It should be rancidity free and pure.

(*b*) It should have a good white tone and

(*c*) It should have a firm texture and should melt between 40-50°C.

Vegetable tallows mentioned above satisfy all these requirements and are therefore admirably suited for yarn sizing and other industrial applications.

Availability of raw material for vegetable tallow in this country.

Species.	*Seeds.* (maunds)	*Vegetable Tallow* (maunds)
1. *Vateria indica*	10,000	2,500 piney tallow
2. *Shorea robusta*	1000,000	150,000 sal butter
3. *Bassia sp.*	840,000	250,000 mowra tallow
4. *Garcinia sp.*	10,000	2,500 kokum butter
5. *Sapium sebiferum*	10,000	2,500 Chinese vegetable tallow
Total yield*	1,870,000	407,500

The University of Bombay has conferred on the textile industry a great boon by providing the University Technological Laboratories which, during their short existence, have rendered valuable service to the industry not only by providing trained students but also by solving problems which confront any industry. We should mention in this connection the excellent work done by the Cotton Technological Institute at Matunga under the able guidance of Dr Nazir Ahmed.

In the Benares Hindu University valuable work on vegetable oils and soaps, glasses and ceramics from raw materials available in India has been conducted, and there is no doubt that the information gathered there in this direction is bound to be industrially exploited in the near future.

At Bangalore, there has been a greater interest taken in industrial research and the gas-mantle industry has already been promoted and the sandal-wood-oil industry and the white lead industry owe much to the work done for them at the Indian Institute of Science, Bangalore.

At Lahore the industrial problems which are being tackled fall in the domain of petroleum, jute, cotton, oils, cements and rice industries. Recently we have initiated manufacture of liquors and juices from citrus fruits and the Kissan products of Captain Mitchell have won wide recognition. There are other centres which have done equally well, but all the work done does not get through to the public or the business man.

It is absolutely clear that there should be an All-India Industrial Research Council to bring the heads of the university research departments and the captains of industry together in order to discuss and evolve an active programme for the industrial development of the country. This All-India Council may have provincial branches, but it would be fatal to fix provincial limits to industries particularly in the present stage of our developments.

If the governments have not done much to initiate new industries, the reasons have not been entirely political. Our industrialists and scientific workers are as much to blame. The attitude of the student community in this respect is well known. They prefer the Government service to an equally remunerative or even a better post in industry. They are afraid to run risks. Owing to the paucity of Government posts, there is, however, a change in their frame of mind and just like the Indian capitalist, they are now less afraid to take more risks. One hopes and prays that this new attitude would continue not on sentimental grounds but as a matter of a considered programme before the nation.

All classes of people can help in this process of nation building.

1. The capitalist can help by his benevolence and gathering courage to invest on planned industries.

2. The Government can help

   (*a*) by allowing subsidies, protective tariffs and loans to industries and by promoting State and semi-State industries;

   (*b*) by procuring financial help from the rich by the method of gentle persuasion the

*In good seed years the yield of seeds is easily two to three times this amount.

technique of which is entirely their own. This has enabled them to raise charities and memorials on special occasions. The finances so obtained should be utilized in developing big industries which no single financier in India can undertake;

(c) by helping in bringing about "mergers" or combinations of industrial enterprises and stopping cut-throat internal competition;

(d) by gradually reducing expenditure on administration and effecting a more balanced distribution of remuneration in their services;

(e) by diverting funds thus saved to improving the system of education so that it is more suited to our present-day needs.

3. The universities can help

(a) by directing their energies to making education a real incentive to work. A man is truly educated if he knows how to make a tool of every faculty how to open it, how to keep it sharp and how to apply it to all practical purposes and to all contingencies of life;

(b) by creating new knowledge without which no industry can exist or stand competition;

(c) by supplying to those interested material and data which may lead to the ultimate development of industry and agriculture and by allowing freely the use of talent and material available with them for industrial development.

4. The students can help

(a) by returning to the land and to the professions which they now despise;

(b) by recognizing the dignity of labour, for

"It is to labour and to labour only, that man owes everything of exchangeable value. Labour is the talisman that has raised him from the condition of the savage; that has changed the desert and the forest into cultivated fields; that has covered the earth with cities, and the ocean with ships; that has given us plenty, comfort and elegance, instead of want, misery, and barbarism."*

*Based on a lecture delivered under the auspices of the National Institute of Sciences at Bombay.

MEDICINE AND PUBLIC HEALTH

The Control of Leprosy

The following points emphasized by Dr R. G. Cochrane of Madras (*The Medical Practitioner*, Sept., 1938) needs a wider appreciation by the public:

(1) Leprosy is not a highly contagious disease and not every type is contagious.

(2) Leprosy is dangerous in childhood and there is evidence to show that the younger the child and the closer the contact with an infective case the more likely is leprosy to develop.

(3) All forms of leprosy are not equally serious, certain types are comparatively innocuous and tend to become spontaneously arrested.

(4) The only known method of control is the prevention of contact of healthy persons, especially children, with cases in the infective stage of the disease.

(5) The pauper leprous beggar, while objectionable, does not constitute the major danger to society; it is the infective case in the home, unisolated and mixing freely with children, which constitute the gravest danger.

(6) Frequently the less obvious cases are more infectious, many of the more obvious cases belong to the comparatively benign neural type of leprosy and are not contagious.

Investigations are being pursued which may result in devising a system whereby the infectious cases will be isolated in the home, village or institution and thus be prevented from coming into close contact with healthy persons, especially children. In so far as leprosy is not infrequently present in families of good social standing, it would contribute materially towards its control if the following elementary precautions were observed:

(1) Separate room, bedding, eating, washing utensils, separate chair.

(2) Avoidance of close contact with individuals in the household, especially children.

(3) Disinfection of all clothing before it is sent to the laundry.

A word with regard to treatment. It must be remembered that all types of leprosy do not need treatment; the first duty of the patient is to consult a competent physician and ascertain whether he requires treatment for his disease and whether it is infectious or not. If treatment is required, the following points should be remembered:

(1) Avoid all medicines which are advertised to "cure" leprosy.

(2) Remember the latest vaunted remedy is seldom the best.

(3) Hydnocarpus Oil (Chaulmoogra) or one of its derivatives such as the esters still remain the basis of treatment.

(4) Generally speaking the best methods of administration are the subcutaneous and intradermal routes.

Persons who are unfortunate enough to suffer from leprosy must not imagine that there is a royal or quick route to the healing of their malady; patience, perseverance and co-operation are the key notes to success. Specious promises of rapid relief and cure are unreliable, and only bring discredit to the treatment and disappointment to the patient. It may however be said that while the treatment of leprosy is still far

from satisfactory, yet given intensive and intelligent treatment, there is a reasonable chance of healing, and he would be a bold man who says any case is hopeless.

A Suggested Plan for the Modern Treatment of Malaria

Lt-Col. G. Covell, I.M.S., Director, Malaria Institute of India, advises the following plan for the modern treatment of Malaria:

"When the cinchona alkaloids were first used for the treatment of malaria, the practice was to administer the drug only during the stage of actual fever. Later, since it was found that relapses occurred in a large proportion of the patients so treated it became customary to prescribe a prolonged course of treatment, lasting over a period of several weeks, or even months. This was the state of affairs at the commencement of the Great War. On certain fronts, notably in Macedonia, where a very large number of cases of malaria occurred amongst the troops, not only were long courses of quinine treatment given, but the drug was administered in very large doses, even up to 100 grains a day. In spite of this however, relapses continued to occur.

Recent researches in connection with the treatment of nervous diseases by malaria therapy, together with the result of a series of carefully controlled experiments carried out in several different countries under the auspices of the Malaria Commission of the League of Nations, have brought about a tendency to revert to the original practice of giving moderate doses of the cinchona alkaloids, or of quinine alone, over short periods of about 7 days, this being followed up by a further similar course in the case of any relapse which may occur. The relapse rate is little if at all greater when this practice is adopted than when longer courses of quinine are given, and the patient is not subjected to the depressing effects of a long course of the drug.

As regards the synthetic antimalarial drugs which have been placed on the market in recent years, the best known are atebrin and plasmoquine. Atebrin, given in courses of 5 to 7 days, has practically the same action as quinine without producing the subjective effects (buzzing in the ears etc.) which are so much objected to by certain patients. Plasmoquine given in small doses over a period of 5 days, is a useful adjunct to quinine or atebrin treatment in the case of benign tertian malaria as a preventive of relapses, to which this form of disease is particularly liable. Plasmoquine may be given concurrently with quinine but if atebrin is the drug selected the plasmoquine course should never be given at the same time, but should follow after an interval of one or two days.

The synthetic antimalarial drugs, useful as they are under special circumstances, should not be given without medical supervision owing to the risk of certain ill effects which may follow when they are administered in unsuitable cases. They are now prescribed in much smaller doses than formerly but even so they are not considered suitable in their present form for indiscriminate use by the public. They have been given with success, however, in the case of labour forces in plantations and other commercial concerns, where strict medical supervision is available.

For self-treatment, and for the treatment of a population on a large scale, where the drug is distributed by laymen, cinchona febrifuge and quinine remain the drugs of choice. The higher price of the synthetic drugs as compared with that of the cinchona alkaloids is an additional reason for preferring the latter for mass treatment or prophylaxis."

Medical Care of Workers in an Indian Industry

M. Ahmad

The subject of specialized medical care of the industrial worker is of recent origin. Its development is closely associated with the introduction of social legislation in the form of accident and social insurance of the workers. In the year 1883 an insurance law protecting the industrial worker against accidents was introduced in Germany, followed in 1889 by compulsory insurance for working men against invalidity and old age. Almost every European country and Japan have from time to time, since 1883, introduced numerous social legislations effecting a steady improvement in the health and working conditions of the worker. The earliest effort to improve the lot of the working man in India came as late as 1924 with the introduction of Workmans' Compensation Act, and the first attempt at social insurance is to be found in the Maternity Benefit Act of Bombay in the year 1929. The last Royal Commission on Labour recommended a scheme for sickness insurance and the recent Cawnpore Labour Enquiry Committee strongly stressed on the need for further consideration to be paid to the recommendations of the Royal Commission. Things move proverbially slowly in India, and it seems to us that such important matters as the wealth of the working man or the economic problems directly connected with the improved health conditions of the industrial workers of India are not receiving the amount of attention that they deserve.

In the year 1933 an experiment was started at a shoe factory near Calcutta then employing about 200 workers, the present number being over 3500, with the object of finding the applicability of modern industrial medicine to the special conditions prevailing in India. The first pleasant surprise came when it was found that the myth about the inherent mulish orthodoxy of the Indian workman who is pictured as refusing to accept the introduction of progressive measures was non-existent. The Indian workman is as keen as any working man in the world to have his lot improved by progressive legislation. After a meeting of the workers and the management, a scheme was introduced whereby every worker paid into the "health fund", thereby effecting a health insurance for himself and his family. The subject, into two categories of medical care was divided.

(1) Preventive and (2) Curative.

The following is an account of the scheme of medical care of workers in which the present writer is interested.

The question of preventive measures involved, besides the usual sanitary regulations, the problem of preventing unhealthy labour from finding his way into the factory. We adopted the slogan '*we keep fit men fit*', and introduced a system of compulsory health examination of every worker before employment closely following the method advocated by Dr V. Tolar, M.D. of Bata Hospital at Zlin, Czechoslovakia. This needed a great deal of co-operation between the management and the medical department. With the assistance of the Personnel Department every applicant for a job is passed through the Medical Department. The applicant is first interviewed by a clerk who presents him with a booklet entitled the 'Health Enquiry'. This booklet is written in two languages and contains a full enquiry into the personal and family history of the applicant, his habits and mode of life and his past and present illness if any. The clerk helps him to understand any difficulties, and in cases of complete illiteracy writes out the answers to the question for the applicant. The candidate then interviews one of the doctors and the medical examination commences. The medical examination takes about fifteen to twenty minutes. Its aim is to rapidly eliminate physical deformities if present and to detect the presence of any disease. He is then weighed, measurements of the chest, abdomen height, standing and sitting down, and the measurements of the bi-acromial and bi-trochanteric conjugates are taken, his urine is examined and his vital capacity is recorded. In doubtful cases his blood is examined and where considered necessary a radiological examination of the chest is undertaken. The last two examinations are ordered for the next day. The teeth are examined and then the applicant is classified according to the findings into five categories, *viz*:—AA, A, B, C, D. Those in

the first three categories are recommended for employment, last two categories are declared unfit, sometimes in suitable cases applicants in category C, are recommended for re-examination after a period of six or eight months.

It is remarkable as to what a variety of pathological conditions one meets with in apparently healthy individuals. At the present moment unsuspected and undiagnosed myocardial changes are engaging our particular attention. We have not had sufficient time to collect conclusions, nor have we had any facilities for scientific investigation but judging by the result of our enquiries and clinical examinations we venture to put forward the statement that the one common factor in our series of one hundred cases of myocardial changes have been nutritional deficiency, a few cases of this series gave a definite history of epidemic dropsy. We are labelling some of these cases as 'H' cases and taking them in, hoping that at a future date we shall be in a position to study them scientifically. Their tickets are permanently marked with the letter 'H' and it would be an easy matter for us to pick them out from the factory. In the mean time they have to report to us periodically to enable us to follow their progress, their fatigue tolerance is noted and the conditions under which some of them break down in spite of regular treatment is recorded. The experience thus gained would be invaluable to us for guidance in future.

From October 1937 to July 1938 we examined 1355 cases, and out of these 34 were classed under the category 'AA', *i.e.*, 2.5 %, 344 under category 'A', *i.e.*, 25.4 %, 833 in category 'B', the percentage being 61.5, and 144 classed under category 'C' giving a percentage of 10.6. It is unsafe to draw any conclusions from these figures extending as they do only over a period of less than a year but one feels that while safeguarding the interests of the employer health examination creates no great hardship on the workers, because, contrary to our fear, the percentage of rejections is remarkably low, considering the high rate of morbidity in Bengal, following malaria, dysentery, kala-azar, epidemic dropsy, etc.

The majority of our workers are from Bengal. Taking two hundred applicants who have been examined we find that the average age is 22 years, the average height and weight being 5 ft. 5 in. and 7 st. 4 lb. respectively. In looking for fitness in our men we are not guided by any absolute standard of measurements and physical development. We ask ourselves the question: Is the man fit for employment in an industrial concern? Is his physical and mental make-up such as to stand up to the strain of factory work and give the factory the maximum result? We wish to note here that time after time we have come across individuals who, although physically fit and educationally well equipped, have proved utter failures as factory workers due to failure of adaptation: they are, so to say, psychological misfits. It is too early in the day to talk of psychological misfits under the conditions prevailing in India today, but we feel sure that a careful collection of data would prove of invaluable service. Experience has shown that the majority of the boys who have received university or high school education in India are psychologically rendered unfit for any work where manual labour or hard work with prolonged application is needed. When we consider that the saturation point for clerical and higher government jobs is nearly reached and that in the India of tomorrow rapid industrialization will demand the services of not only the working classes but also of the socalled *bhadralog* class it becomes a matter of grave concern to the country as to whether we are not wasting too much time and money on the system of education which from an industrial point of view is worse than useless.

To keep a fit man fit, the work of the Medical Department does not stop at just at prescribing medicines in cases of sickness. Apart from looking after the environment, sanitation and hygiene of the factory and workers, it has to get busy helping the management in the organization of physical culture, games and amusements; it exercises an adequate supervision over the food supply of the workers, and advises on dietetics. The addition of a few special reagents to the clinical laboratory to enable one to carry out food tests is an added advantage.

In factories where women are employed the medical care must include a maternity and child welfare clinic. The maternity clinic must be in charge of a clinician well trained in ante-natal routine with a good knowledge of practical gynaecology and midwifery. It is not essential to employ a woman doctor.

Our experience at one of the factories shows that pregnancy anaemia is not as common a feature as one would expect. Actual records of all the cases seen are

not available at the moment but out of a series of 100 cases the blood picture in four cases only is fairly typical of pregnancy anaemia. These cases did remarkably well on "Liver Concentrate" preparations. The majority of the cases however show a red cell count of below the 4 million mark. It is interesting to note that in this series of cases no abnormality in pelvic measurements was found, showing that the working woman is a better developed individual than her town sister, meaning the class one meets at a place like the out patients' department of a hospital like the Eden Hospital or better still in the homes of *Purdahnashin* muslims.

Our ante natal records are kept on printed cards and indexed for reference. With a few modifications we have found it useful to adopt the scheme followed by the London County Council as demonstrated to us at the ante natal clinic of Professor James Young at the Bristol Post Graduate Hospital, London. We have made it a rule that no maternity benefit be paid by the office unless the papers are passed by the Medical Department. In this way every maternity case is brought under our notice. We feel tempted to make an observation here that the incidence of puerperal sepsis is remarkably low amongst the working women under our supervision. Only one case in six years out of 300 cases was seen. According to our conception of asepsis and cleanliness, seeing the methods of accouchement adopted by these women we ought to have got a large number of morbidity following child birth, but such is not the case. In the midst of filth and squaller the working woman brings forth her babies and she generally escapes without any injury and is up and about on the third or the fourth day. The case of the women of the Santhal Parganas is particularly interesting. They adopt the squatting position for confinement and have remarkably quick and easy labours. The good results may be attributed to their well developed muscles, their natural diet, the squatting position they adopt and the freedom from any interference from the doctor or the nurse. Child birth is a physiological process, the modern living conditions alone are responsible for the pathological states we meet with in our town practice.

We run a creche for the babies whose mothers work in the factory. After a considerable experience we have learnt that it is best to run the creche on the lines of the home conditions of the workers. It is useless to attempt to follow the high standard of an institution in Europe by getting them baby cots and white sheets and good clothes. Unless the economic conditions of the parents improve it is little use trying to get these little mites accustomed to things which they cannot afford in their homes. We therefore keep these babies on cheap clean beds made of gunny bags spread on the floor with pieces of mackintosh cloths as protectives for the matresses. To look after the babies we employ Indian maid-servants, and in every case we encourage the mothers to come in every four hours to feed the babies. Bigger children are given feeds of Indian biscuits and milk.

Turning to the curative side of our work, medical and surgical aid is given in all cases of sickness and accidents to the workers. We also give medicines and medical aid to the wife and to a maximum of three children of the workers. The word 'worker' means every one employed in the company either in their offices or in the factory. The medical department should consist of an uptodate out patients' department, fitted with a clinical laboratory and X-rays. Dental service is given free as a part of the medical aid, except in cases of prosthetic dentistry, when a reasonable charge is made to cover the extra cost.

Every factory should have its own cottage hospital. We have found that eight to ten beds in an ordinary bungalow type one-storey building with tiled roof costing about Rs. 1,200 - serves the purpose of a factory employing over 30,000. Where no women are employed, two male nurses and a couple of orderlies carry out the nursing duties quite satisfactorily. In a cottage hospital of this type we do not aim at reproducing the elaborate modern conditions to be found in bigger hospitals. The cottage hospital besides providing improved facilities for medical work and clinical observation has proved to be of distinct value in minimizing malingering. Proper records of all the out patients and hospital cases are kept on the card index system. The average cost per year per out patient works out to four annas per head per year. The entire medical expenses are borne by the Health Insurance Scheme* to which the employers as well as the employees subscribe weekly.

* The details of the scheme have been published elsewhere earlier under the title 'A Health Insurance Scheme for the Industrial Workers of Bengal.'

RESEARCH NOTES

Nature of Primary Cosmic Rays

From depth ionisation curves at different latitudes and upto heights corresponding to 98.8% of the way to the top of the atmosphere, Bowen, Millikan and Neher (*Phy. Rev.* June, 1938) conclude that charged cosmic ray particles enter the atmosphere only in a definitely limited and relatively narrow energy range. The maximum of this energy distribution curve lies at about 6.10^9 eV. At 1.10^9 eV the curve has fallen to about a third of its maximum value, and on the other side of the maximum at some 17.10^9 eV the incoming energy also has about a third of its maximum value. The fraction of the total incoming energy that can be assigned to photons is small. This smallness shows that cosmic rays cannot ever have come through an amount of matter appreciable in comparison with an atmosphere before entering the Solar system.

Swann has shown that enormous potential differences would exist between relatively close points in interstellar space if any appreciable fraction of the radiation were unneutralised in the statistical sense. These potentials go up as the square of the distance, and assuming the primaries to be positives the potential difference between points at a distance of one light year will be 7.10^{15} volts. Any theory of cosmic radiation must therefore provide for a statistically neutral primary radiation.

Johnson (*Phys. Rev.*, 1 Sept. 1938) puts forward a hypothesis about the nature of primary cosmic radiation which satisfies both these demands. He assumes the existence of some unspecified process within the atmospheres of stars in which either electrons or positive ions are given an original impulse. As these pass outwards through the stellar atmosphere, secondary positron-negatron pairs and an equilibrium intensity of photons are generated. The charge of the primary particles, being of one sign, raises the potential of the star to the point where opposite charges are repelled and both types of particles move along with *equal velocities*. This is the necessary and sufficient condition for an equilibrium in which there is no space charge at infinity and a steady potential on the star. The heavier particles have most of the energy. The secondary photons pass out into intergalactic space and are lost, while the charged particles are retained by a galactic magnetic field. When these encounter the earth's field the positrons and negatrons pass through in equal proportion and constitute the soft component primaries. Of the other rays, only the heavy positives have sufficient energy to reach the earth's surface. There they constitute the positive primary radiation, whose penetrating secondaries produce most of the intensity at sea level and below and account for the east west asymmetry.

D. R.

The Iowa System of Qualitative Analysis without Hydrogen Sulphide

Among nearly a score of methods proposed from time to time for the qualitative analysis of cations without the use of hydrogen sulphide, the Iowa system, recently proposed, is perhaps the most easily workable. The system divides the common cations, (1) lead, silver, mercury (ous): (2) barium, strontium, calcium: (3) mercury (ic), bismuth, iron, copper, cobalt, nickel, cadmium, zinc, arsenic, antimony, tin: (4) manganese, magnesium, aluminium, chromium: (5) ammonium, potassium and sodium,

into five groups indicated, using group reagents hydrochloric acid, sulphuric acid and alcohol, normal ammonium sulphide in acetate-acetic acid buffered solution, and normal ammonium phosphate in alkaline solution respectively.

The details for the isolation and detection of each individual cation have been worked out, and given in seven auxiliary tables by Jacob Carnoy, of the University of Iowa. (*J. Chem. Edu. 15*, 420, 1938). A real merit of the system lies in the fact that the presence of phosphates in the original sample causes no serious dislocation of the system. The author claims that students detect zinc and magnesium more frequently with this system than with the classical one using hydrogen sulphide; and that the air of the laboratory is reasonably pure so long as not more than thirty students are working at once. The chief defect of the system pointed out by the author of the system, *viz.*, the frequent failure to detect mercury in course of analysis, does not appear to be a serious one, since there are common preliminary tests for detecting this element in a mixture.

J. G.

The Velocity of Sound in Liquid Helium

The physical properties of liquid helium have been engaging the attention of many workers for the last few years. Keesom (1932) first observed that there is catastrophic change in the specific heat of liquid helium at about 2·19°K and at still lower temperatures the heat capacity diminishes gradually to values lower than those at temperatures higher than 2·19°K. Liquid helium thus exists in two phases, He I and He II above and below the λ point respectively. It was observed by Rollin (1935) and Keesom and Keesom (1936) that He II shows an extraordinarily high thermal conductivity. Allen, Peierls and Zakiuddin (1937) while investigating the thermal conductivity of liquid helium observed some anomalous behaviour near the λ-point. Kapitza (1938) observed that the viscosity of He II is about 1500 times smaller than that of He I at normal pressure, and is 10^4 times smaller than that of hydrogen gas.

The velocity of sound in liquid helium under its vapour pressure has been determined recently over a range of temperature from 4·22°K to 1·76°K by Findlay, Pitt, Smith and Wilhelm and the results have been reported [*Phys. Rev., 54*, October 1, 1938]. The method of measuring the velocity of sound by ultrasonic waves in condensed gases developed by Pitt and Jackson has been modified to obtain standing waves in liquid helium having high compressibility and small density. At temperatures slightly removed from the λ point, the values of compressibility calculated from the observed velocity of sound are in fair agreement with those estimated from thermodynamical considerations. It is striking, however, that no discontinuity has been observed at the λ-transition.

S. S.

UNIVERSITY AND ACADEMY NEWS

Royal Asiatic Society of Bengal

(Calcutta, 7th November, 1938)

(1) A manuscript of a hitherto unknown work of the Nakulisa Pasupatas (exhibited) By Chintaharan Chakravarti.

(2) Indian ladies playing Polo (exhibited) By Percy Brown.

(3) Recent exploration in Tibet By Johan van Manen.

The following candidates were elected Ordinary Members during the recess months, under Rule 7:

Bernardo Dominguez (Calcutta); M. D. Rahaman (Ranchi).

The following candidates were balloted for as Ordinary Members:

Jhr. P. J. Eckhout (Calcutta); Kanai Lall Jatia (Calcutta).

Botanical Society of Bengal

(Calcutta, 14th November, 1938)

Studies in the fungal flora of the paddy fields — By T. C. Roy.

National Academy of Sciences, India

(Allahabad, 29th October, 1938)

(1) On two new Trematodes from Indian cyprinoid fishes with remarks on the genus Allocreadium Looss By B. P. Pande.

(2) A new Strigeid Trematode of the Genus Crassiphiala V. Haitsma, 1925 (Family: Diplostomidae Poirier) from an Indian King fisher By B. P. Pande.

(3) A note on the telescope method for determining the focal length of lenses and mirrors By Sukhdeo Bihari Mathur.

(4) F_2-region Ionization in June 1938 at Allahabad By K. B. Mathur and G. R. Toshniwal.

(5) Chemical Examination of the essential oil of Ocimum Canum Sims By Jagat Narain Tayal and S. B. Dutt.

Society of Biological Chemists, India

(Bombay, 30th August, 1938)

(1) The excretion of Vitamin C in urine and the state of saturation in normal individuals in Bombay By Dr A. Fernandez.

(Indore, 10th September, 1938)

(2) The disposal and utilization of horse dung and stable litter by composting By Prof. K. A. Patwardhan.

(Indore, 22nd September, 1938)

(3) Essential oil from flowers of Mendhi, and laboratory synthesis of products occurring in plants By Dr S. S. Deshpande.

(Cawnpore, 10th September, 1938)

(4) Membrane permeability By Dr A. N. Rao.

(Bangalore, 14th September 1938)

(5) Cloves By A. K. Yagnanarayana Iyer.

(Bangalore, 30th October, 1938)

(6) The availability of calcium and phosphorus in a few typical Indian diets By V. Ranganathan.

(7) The Chemotherapy of Bacterial infection By K. Ganapathi.

(8) Nitrogen fixation at laboratory temperatures and its probable significance in agriculture By A. L. Sundara Rao.

(9) Effect of calcium on the biological value of the proteins of Indian diets By V. Ranganathan and Y. V. S. Rau.

(10) Chemistry for fiscal purposes A lecture.

Research Work in India

Royal Institute of Science, Bombay (1937-38)

The work in the Botany department was confined to plant physiological, plant ecological, plant geographical and cytological research.

Various types of ecological problems were investigated with a view to have a Botanical Survey of Bombay and Salsette islands. The vegetation were divided into certain plant associations and detailed ecological work of three associations is on hand, *viz.*, (1) The Mangrove Association, (2) Ruderal Association, and (3) The Nitrophilous Association. The work on the first association is fairly advanced and a map of the distribution of this association on the Bombay and Salsette islands is nearly complete. The dominant plant of this association is *Avicennia alba*. The ruderal association is dominated by *Cassia tora*, whereas the nitrophilous association found in waste places near human habitations is allied to the ruderal association by the possession of many common species. The most characteristic plants of the nitrophilous association seemed to be *Malachra capitata* and *Ficus hispida*. The delimitation of these associations and their correlation to the soil factors is now under hand. The other ecological problem under consideration is the study of the life forms of the plants of the Deccan.

A systematic morphological study of the pollen grains of the Indian grasses was undertaken with a view to find out how far such a study will verify European and American classification. Recent work to measure the transformations produced in soil by the oxidation or reduction of the organic matter by bacteria and fungi by measuring the oxidation reduction potential is under progress with soils of different plant associations of Bombay.

The problem of improvement of the grassland, is being investigated near Kalyan. The main points under consideration are, (*i*) the division of the grassland into different associations (*ii*) mapping of the grasslands on the basis of the association and (*iii*) formation of a scheme of plant succession and finally (*iv*) investigating each plant association in detail in terms of its various factors.

Plant physiological investigations included work on the respiration of *Avicennia alba* and other mangrove species with a view to find out the rate of respiration of these plants and their rhythm according to the seasons of the year.

The growth of rice seedlings in solutions of nitrates, sulphates and phosphates of sodium, potassium, ammonium, magnesium and calcium and two water cultures, *viz.*, Tottingham's, and Knop's of different pH has also been studied. Maximum growth of rice seedlings occurred in all salt solutions with a pH 7.0 or 7.2. In solutions of maximum salts and phosphates of other salts maximum growth was at pH 7.0, while in the rest of the solutions and in the two cultures the maximum growth was at pH 7.2. The favourable pH for the growth of rice seedlings was between pH 6.8 and 7.4. Growth was remarkably suppressed at pH lower or higher than this range.

In work on the external and internal morphology of certain members of *Iridaceae* and *Liliaceae* the effect of certain substances on the internal structure and the nucleus of these plants is under investigation.

II

The work in physical chemistry was mainly carried out in the study of gels, the photo-reduction of ferric chloride, crystals and the kinetics of some inorganic heterogenous reactions. The gels of phosphate, arsenate and molybdate of thorium, of phosphate and arsenate of tin, of ceric phosphate etc., have been prepared in a transparent state and their viscosity, refractivity, pH, have been measured during the course of setting. Viscosity measurements with thorium molybdate gels which are highly thixotropic, have revealed, time discontinuous curves; in other thixotrophic gels viscosity-time curves are found to be regular and continuous.

UNIVERSITY AND ACADEMY NEWS

The photo-reduction of ferric chloride has been studied in the presence of acetaldehyde in aqueous solutions, using ceric sulphate as the reagent for the estimation of the amount of reduction. The measurements of the quantum efficiency of the reaction show that it increases with an increase in the concentration of the aldehyde but decreases with an increase in the concentration of ferric chloride; increases with an increase in temperature, but decreases with an increase in the wave-length of the incident radiations. It is difficult to say whether the reaction is a zero or uni-molecular one but the heat of activation calculated from Arrhenius' equation using uni-molecular constant is of the same order of magnitude as the heat of dissociation of ferric chloride.

A number of crystals have been studied by X-ray method, two of these being triclinic. In the case of 1:8 dinitronaphthalene the molecules in the unit cell have been found to possess a plane of symmetry and the exact orientation of the molecules is being determined by Krishnan's magnetic method. Crystals of hydrazobenzene and of *p*-azotoluene the molecules of which have also been found to possess an element of symmetry and the crystals are also being investigated magnetically.

It has been found that chromic sulphate reacts with hydrated manganese dioxide and potassium permanganate with hydrated chromic oxide fairly slowly and in each case dichromation is formed as a result of the reaction. The kinetics of these two reactions have been studied and it has been found that the results can be mathematically represented by the relation $V = (a \times 1/b)\ Km - k/b$
where Km is the unimolecular constant, V the velocity of the reaction equal to x/t and k and b are constants. The study of these reactions is being extended.

In inorganic chemistry a new process has been investigated whereby the sulphur content of gypsum is made available in a form suitable for direct conversion into sulphuric acid by heating it to 1000° along with boric anhydride. The residue obtained after heating can be utilised to give boric acid and calcium in a form suitable for the manufacture of cement. The nature of solutions of aluminium and zinc hydroxides in solution of sodium hydroxide has been investigated by various physical methods and under certain circumstances crystals of aluminates and zincates of sodium have been obtained. In the investigation of the behaviour of mixtures of boric acid with hydroxylic substances melting point-composition diagrams have been found to be of the eutectic type in the case of glucose, galactose and tartaric acid but compound formation is evidenced by mixtures containing mannitol and erythritol. Using an expression by Kordes the melting point of boric acid has been calculated and the values obtained are in fair agreement with that obtained recently by Stackelberg and co-workers.

LETTERS TO THE EDITOR

[The Editor is not responsible for the views expressed in the Letters.]

Effect of Drying on Shrinkage of Wood

The seasoning of timber is commonly attended with shrinkage. The fundamentals of seasoning, however, demand that there should not be undue and irregular shrinkage in lumber during the process of its drying. Various processes of seasoning wood are now in vogue. The best of course is the air-seasoning in so far as the uniformity of drying is concerned. It has been levelled in certain quarters that the total shrinkage in similar specimens of wood and for equivalent moisture content is identical irrespective of the processes of drying. This view is perhaps untenable both on theoretical grounds and practical observations. Thus the total radial shrinkage for example, of *CHLOROXYLON SWIETENIA*, as found by the author, is 4.42 per cent (calculated on green wood) when oven-dried at 105°C., 5.42 when kiln-dried and then oven-dried, 5.78 when air-dried for a month and then oven-dried, and 6.28 when air-dried for three months and then oven dried. Similar differences in tangential shrinkage, too, have been observed in the same order, although tangential shrinkage is in every case higher than the corresponding radial shrinkage for equivalent moisture content. A number of such observations were made with a variety of Indian timbers, such as *shorea robusta*, *Adina cordifolia*, *Dichopsis elliptica*, *Terminalia tomentosa*, *Lagerströmia parviflora*, *Dillenia pentagyna*, etc., and similar results were obtained in each case. When the wood is air seasoned, the rate of drying is very slow. Shrinkage, too, is very high, probably because the fibres dry more uniformly and completely. On the other hand when drying takes place under rather warm and humid condition as in kiln-drying process, shrinkage is certainly less. This is because the lumber is dried rapidly, and some parts of the wood become dried and set without undergoing full shrinkage. The point at issue, however, was to show that the rate and mode of drying timber has a marked influence on shrinkage.

Wood in the dead condition may be regarded as a bundle of gels. The latter have no doubt a structure which may either be of Bütschli's honey-comb pattern or similar to Nägeli's brush-heap structure in which minute ultramicroscopic fibrils are interlaced throughout the system and the dispersions medium is held within the fibrillar mass by capillary forces. The same view holds good in the case of lumber as well. Wood and silica gels have many properties in common of which the phenomenon of 'hysteresis' exhibited by wood on its drying and swelling present a striking similarity to that shown by silica gels.

Calcutta, B. N. Mitra.
28. 7. 38.

Electrical Constants of Ionised Air for Micro-Waves

J. S. McPetrie[1] has suggested an interesting method of measuring accurately and conveniently the dielectric constant and conductivity of a conducting medium by Drude's method. It has been pointed out by him that when the dielectric has appreciable conductivity, the distances between successive current or potential antinodes in the Lecher system are not constant but increase to a limiting value as the distance of progression along the medium increases. McPetrie also gives curves from which knowing the ratio l_1/l_2 of the distances of the third and the second antinodes in the medium from the first, the dielectric constant and conductivity of the medium may be determined.

The above method has been utilized, with advantage, to measure the dielectric constant and conductivity of ionized air produced by high frequency electric discharge in a glass tube with experimental arrangement very similar to that employed by Mitra and Banerjee.[2] The practical difficulty of producing more than two antinodes for ordinary ultra short waves and ordinary discharge tube was obviated by employing micro waves of wave-length from 22 cm. to 45 cm. The discharge tube, having the convenient size of 75 cm. length, was placed between Lecher wires and the distances between the antinodes of which there were more than three were accurately measured.

The micro-waves were generated by a split-anode magnetron (G.E.C.—C.W. 10). For determining the position of the antinodes a semi circular short circuiting bridge with an insulating handle was employed, which could be moved freely on the Lecher wires without touching the discharge tube. The experimental results obtained are tabulated below. The second column gives the ratio of the third and the second antinode from the first. Third and fifth columns are obtained from

McPetrie's curves from which the dielectric constant K and the conductivity σ can be calculated.

Wave-length	l_1/l_2	$KF_2 f^2 \times 10^{-20}$	Dielectric constant K	$\sigma F_2 f \times 10^{-20}$	Conductivity σ (e.s.u.)
23 cm.	2.008	2.15	.992	.15	1.13×10^{8}
30 cm.	2.01	2.13	.982	.25	1.16×10^{8}
36 cm.	2.01	2.13	.969	.25	1.19×10^{8}
40 cm.	2.013	2.1	.966	.35	1.20×10^{8}
45 cm.	2.015	2.08	.958	.4	1.22×10^{8}

where l_2, l_1 are the distances of the second and third antinodes from the first and f is wave frequency.

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15-11-38.

A. K. Banerjee.

[1] McPetrie *Nature*, *134*, 897, 1934.
[2] Mitra and Banerjee—*Nature*, *136*, 512, 1935.

A Comparative Study of Vitamin C in a few Germinated Cereals

Vitamin C content of the germinated peas[1] as well as that of the germinated oil seeds,[2] estimated by the titration method of Haris and Roy[3] as modified by Ghosh and Guha[4] and Guha and Ghosh[5] has already been reported. Here also the some method has been employed for the estimation of vitamin C. .

Clean dry mature cereals were first soaked in water for 3 hours. They were then placed in the folds of wet lint and kept in petri dish. In most cases good germination took place in 72 hours. They were worked up for the estimation of vitamin C at interval of 72, 96, 120 and 144 hours after they had been first soaked in water. 10 gms. of the germinated seeds were then taken in a mortar with 2.5 cc. of 20% trichloracetic acid solution and a few gms of Merck's sea sand. The seeds were finally ground with a few c.c. of distilled water and centrifuged. The centrifugate was made up to 100 c.c. and titrated against 2:6 dichlorophenol-indophenol according to the method of Guha and Ghosh as mentioned above. It is to be noted that in the case of the paddy only two samples were done, because the seasonal effect was so great that germination was almost impossible at the end of the rains and the vitamin C also was found to be almost negligible. Dry weights of each sample of the experimental seeds were determined and the amounts of vitamin C in mg. of the substance on the basis of the dry weight have been recorded in the table. The asterisks in the table mark out the maximum value obtained with individual seeds investigated.

Ascorbic Acid in mg. per gm. of the cereals.

Hours of Germination.	Paddy (*Oryza sativa L*).	Barley (*Hordeum vulgare L*).	Wheat (*Triticum vulgare L*).	De dhan (*Arondropogon sorghum L*).	Maize (*Zea mays L*).
72 hours .	0.028	0.038	0.034	0.062	0.065
	0.030	0.045	0.058	0.099	0.070
	..	0.054	0.059	0.067	0.054
Average .	0.029	0.046	0.050	0.076	0.063
96 hours .	0.044	0.051	0.058	0.137	0.098
	0.040	0.055	0.112	0.143	0.079
	..	0.057	0.079	0.124	0.073
Average .	0.042	0.054	0.083	0.035	0.083
120 hours	0.050	0.134	0.169	0.159	0.160
	0.049	0.082	0.142	0.178	0.086
	..	0.085	0.088	0.123	0.065
Average .	0.049	0.100*	0.133*	0.153*	0.104
144 hours	0.061	0.066	0.139	0.140	0.181
	0.060	0.073	0.174	0.187	0.112
	..	0.080	0.082	0.112	0.145
Average .	0.060*	0.073	0.132	0.146	0.146
Ungerminated seeds	0.017	0.020	0.022	0.023	0.018
	0.018	0.024	0.021	0.022	0.022
	..	0.021	0.023	0.023	0.022
Average .	0.018	0.022	0.022	0.023	0.020

From the table it is evident that *De dhan* furnishes the greatest while paddy gives the least amount of vitamin C on germination. When the increase of vitamin C on germination is taken into consideration *De-dhan* is found to increase by 7 times, maize and wheat by 6 times, barley by 5 times while paddy by 3 times only.

Our sincere thanks are due to the authorities of the firm for their constant help and encouragement.

Biochemical Laboratory,
Bengal Chemical and Pharmaceutical Works Ltd.,
Calcutta.
12-10-38.

H. G. Biswas.
K. L. Das.

[1] Science and Culture, *1*, 778, 1936.
[2] Science and Culture, *3*, 176, 1937.
[3] *Biochem. J.*, *27*, 303, 1933.
[4] *J. Indian Chem. Soc.*, *12*, 30, 1935.
[5] *Current Science*, *2*, 390, 1935.

Experiments on the synthesis of certain Keto-acids

The present communication deals with exploratory work of a somewhat varied nature on the construction of molecular species required as intermediates or models for syntheses of

compounds related to natural products. Continuation of the work described in previous paper[1] is thought desirable to study the same scheme with methoxy derivative.

Anisaldehyde cyanohydrin is allowed to react with the sodium salt of ethyl cyanoacetate when the sodium derivative of ethyl $\alpha\beta$ dicyano-β—(p methoxy phenyl)-propionate (b.p. 225°/5 mm.; m.p. 81°C) is obtained. It is allowed to react with ethyl β chloropropionate when diethyl-$\alpha\beta$—dicyano-α—(p-methoxy phenyl)-n butane-$\beta\delta$—dicarboxylate (b.p. 233-236°/4 mm.) is obtained. When hydrolysed by means of sulphuric acid the latter yields α-(p-methoxy phenyl)-n-butane $\alpha\beta\delta$ tricarboxylic acid (m.p. 183°C), the triethyl ester (b.p. 205° 215°/3 mm.) of which undergoes cyclization in presence of sodium in benzene to yield diethyl-2 (p-methoxy phenyl)-cyclopentanone-3: 5-dicarboxylate (b.p. 202 212° 4 mm.). This ester on hydrolysis and decarboxylation yields the required 2 (p-methoxy phenyl)-cyclopentanone-3-carboxylic acid (m.p. 135°C).

It has been shown by Thorpe and others[2] that phenyl succinic acid undergoes ring closure to yield 1 ketohydrindene-3 carboxylic acid. An extension of this method for the synthesis of methoxy derivative of hydrindones has been abandoned when it is found that the ring closure of p-methoxy phenyl succinic acid is by no means so smooth a process as has been the case with phenyl succinic acid. However, the alkyl derivatives of the phenyl succinic acid undergo ring closure and these are being utilized to elucidate the constitution of some natural product.

p-Methoxy phenyl succinic acid (m. P. 205°C) required for the above experiments is prepared by hydrolysing ethyl $\alpha\beta$-di-cyano-β -(p-methoxy phenyl)-propionate with sulphuric acid. Ring closure of the acid is tried with P_2O_5, $SnCl_4$, 80% H_2SO_4 and conc. H_2SO_4. With first three reagents the acid is obtained unchanged after working up the reaction product whereas with conc. H_2SO_4, the acid completely goes into solution. The ring closure of diethyl-p-methoxy phenyl succinate (185°/4 mm.) in presence of P_2O_5 is tried next. In this case also the unchanged ester is recovered from the reaction mixture.

The aim of this part of investigation is to work out a method for the synthesis of 1:2 dicarboxy tetrahydronaphthalenes, which are important for the synthesis of benzanthrene derivatives with carcinogenic property. Benzaldehyde cyanohydrin is allowed to react with the sodium salt of ethyl-cyanoacetate when the sodium derivative of ethyl $\alpha\beta$-dicyano-β-phenyl propionate is obtained. It is allowed to react with ethyl-chloroacetate when diethyl-$\alpha\beta$-dicyano-α phenyl-n-propane-$\beta\gamma$-dicarboxylate (b.p. 205°-207°/4 mm) is obtained. When hydrolysed by means of H_2SO_4 the latter yields α-phenyl-n-propane-$\alpha\beta\gamma$-tricarboxylic acid (m.p. 204°C; triethyl ester b.p. 185°-190°/5 mm.). This acid in presence of H_2SO_4 undergoes ring closure to yield a keto acid (m.p 179°-182°C). That a second ring was formed is proved by the fact that the compound on oxidation gave phthalic acid. Experiments are in progress to determine the constitution of the above keto-acid.

α-(p-methoxy phenyl)-n-propane $\alpha\beta\gamma$- -tricarboxylic acid (m.p. 190°; triethyl ester b.p. 210°-215°/5 mm.) obtained by hydrolysing the condensation product (232°-237° 3 mm.) of ethyl-$\alpha\beta$-dicyano-β-(p methoxy phenyl)-propionate with ethyl chloroacetate on the other hand, under similar treatment does not undergo ring closure. The acid undergoes complete sulphonation in presence of conc. H_2SO_4.

Our respectful thanks are due to Sir P. C. Ray and Prof. P. C. Mitter for their kind interest in the work.

Chemical Laboratory,
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Nripendra Nath Chatterjee.
Girindra Nath Barpujari.

[1] *J. Ind. Chem. Soc.*, 15, 211, 1938.
[2] *J. Chem. Soc.*, 2185, 1924.

Vitamins B_1 and B_2 content of a few Samples of Bread

The consumption of bread is gradually increasing both in our towns as well as in our countryside. This fact has drawn our attention to the estimation of the wellknown B-vitamins in this important article of dietary.

The biological method of assay with young rats as modified by Guha and Chakravorty[1] was followed for the estimation of vitamins B_1 and B_2 in this case.

Five rats of each group deficient in vitamins B_1 and B_2 respectively were fed with 2 samples of bread for 3 weeks and their average weekly growth was determined. The samples of bread tested were bought fresh from the Calcutta market every day.

In the following table the results of the experiments are given in terms of the units as defined by Guha and and Chakravorty[2].

Bread No. 1.

Brown		*White*	
B_1	B_2	B_1	B_2
28.0	28.3	11.6	10.3

Bread No. 2.

Brown		*White*	
B_1	B_2	B_1	B_2
14	15.6	17.2	9.0

The brown variety of the bread N. 1 has been found, as expected, to contain a much larger amount of the B vitamins than the white variety. In the case of

the bread No. 2, however, there is practically no difference in the content of the B-vitamins in the two varieties.

It is evident from the above experiments that breads of different manufacture vary greatly in their vitamins B_1 and B_2 content.

My sincere thanks are due to the authorities of the firm for their constant help and encouragement during the progress of the work.

Biochemical Laboratory, H. G. Biswas.
Bengal Chemical & Pharmaceutical Works, Ltd.
Calcutta.
13-10-38.

[1] *Ind. J. Med. Res.*, *20*, 1045.
[2] *Ibid.*, *21*, 221.

Quantitative Spectroscopic Analysis of Plant Products

Favourable effects of micro constituents like Mn, Zn, Mo, Ni and I on plant growth have been noted by numerous investigators. Hoagland[1] and others found that Zn salts have a striking curative effect in diseases of fruit trees known as "mottled leaf" while Gerretsen[2] believes that the immunity of the plant is closely related to its manganese content. H. Meulen[3] identified Mo by the colorimetric method in many plants and vegetable products and in fertile soils. It is certain that these trace elements exert specific effects on soils favouring plant development, though there have been differences of opinion as to the real nature of the influence.

The separation and determination of these micro constituents by the usual chemical methods is a matter of extreme difficulty. The superiority of the spectrographic methods for the estimation of these trace elements has been previously pointed out by the author.[4] H. Ramage[5] has applied spectrochemical methods to studying the biological distribution of metals and many facts regarding selective secretion and distribution of certain metals in plants and seeds have been described. The present note deals with the identification and quantitative estimation of Zn and Mo in amaranthus and peas.

The essential feature of the method used for the determination of the concentration was a comparison of the line intensities. Known amounts of these elements are introduced into a sample mixture which furnishes spectrum lines of intensity depending on the concentration. These serve as comparison standards for estimating the percentage of the minor constituents to be determined in the sample.

In preparing the samples for analysis, they were first dried and then ashed at less than 450°C in platinum. For the detection and estimation of Zn, the line 2138.6 Å, the most sensitive of the Zn lines, is used while for Mo, the three lines 3798 Å, 3864 Å and 3903 Å which constitute the 'raies ultimes' are used. The details of the method of arcing are described in a previous publication (*loc. cit.*). Typical spectrograms obtained are shown in Fig. 1 (a) and (b). Four different samples of each have been examined.

Fig. I (a) Mo.

Amaranthus

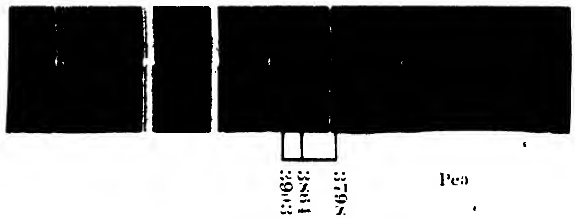
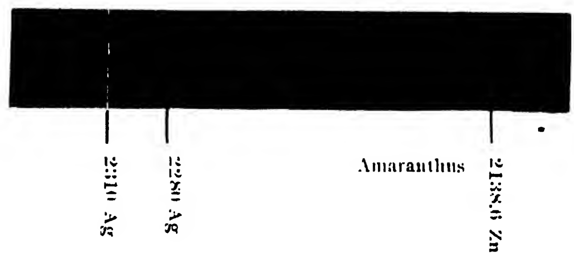


Fig I (b) Zn.

Pe..



Peas contain large amounts of Mo ranging from 8 to 11 mgms. per kilo of dry material, while amaranthus showed only traces of it (less than 1 mgm. per kilo). The average Zn content of the peas examined is 40.2 mgms. per kilo of dry material and that of amaranthus varied from 25 to 30 mgms. It may be noted here that the variations in the analysis might be due to variations in the soil conditions as the samples for analysis were obtained from the local market.

It will also be seen from the spectrograms that though the Mo content of the samples is relatively lower than the Zn content the Mo lines appear more markedly. This is due to the greater spectral sensitivity of Mo than Zn.

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Bangalore.
11-11-38.

[1] Hoagland *Trans. Int. Cong. Soil Sci.*, 3, 216, 1935.
[2] Gerretsen—*Ibid.*, *1*, 189.
[3] Meulen, H.—*Nature*, *130*, 966, 1932.
[4] Sundara Rao, A. L.—*Proc. Ind. Aca. Sci.*, *sec. B. 6*, 91-97, 1937.
[5] Ramage, H.—*Nature*, *137*, 67, 1936.

Obituary

N. G. MAJUMDAR

We regret to record the untimely death of Mr Nani Gopal Majumdar, M.A., F.R.A.S.B., Special Officer for Exploration of the Archaeological Survey of India, who was murdered under most tragic circumstances on the 11th November, 1938, near Johi in the Dadu District of Sind. He had been specially deputed from 1st October, 1938, for six months to complete a survey of the prehistoric sites of the Indus Valley Civilization which he had so successfully carried out from 1927-31. Soon after he started work in the Upper Manchar Lake-area, he was shot dead on the morning of the 11th November by a band of armed dacoits which attacked his camp.

Mr Majumdar, the eldest son of Dr B. Majumdar of Jessore, was born on the 1st December 1897. After a successful scholastic career he joined the Calcutta

N. G. Majumdar.

University and in 1918 pased the B.A. Examination with Honours in Sanskrit in first division and secured a scholarship and the University Silver Medal. In 1920 he passed the M.A. Examination in the first division in Ancient Indian History, and was awarded the University Gold Medal for securing the first position. After his post graduate studies in the newly organised Ancient History Department of the University he devoted his attention to researches in Sanskrit and Epigraphic studies, and derived full benefit from his association with his teachers, the late Mahamahopadhyay Haraprasad Shastri and Prof. D. R. Bhandarkar. It was apparently the influence of Prof. Bhandarkar and the late Mr R. D. Banerjee which was responsible for Mr Majumdar developing a keen interest in Indian Archaeology. During 1921-23 he was awarded the Griffith Memorial Prize and the Premchand Roychand Scholarship which is the blue ribbon of the Calcutta University awards. The Mouat Gold Medal was also awarded to him about the same time. In view of his brilliant scholastic career as a student of the University he was appointed on the staff of Ancient Indian History and Culture department of the Calcutta University soon after he took his M.A. degree. He continued in this appointment until 1924 when he took up the post of Curator, Varendra Research Society, Rajshahi, Bengal. In this capacity he did very valuable work and published a monumental volume entitled *Inscriptions of Bengal, Vol. 3.* In 1925 he was selected for archaeological training and was deputed to Mohenjo-daro where a Calcholithic culture of the prehistoric times had recently been discovered. After this training he was appointed as Assistant Superintendent for Exploration in the Archaeological Survey of India in June 1927, and the first work assigned to him was a survey of the centres of the prehistoric civilization of Sind. On 1st June 1935 he was appointed as Superintendent, Archaeological Section of the Indian Museum, Calcutta, as the successor of Rai Bahadur Rama Prosad Chanda; this post he held until the 1st of October, 1938, when he resumed survey and exploration of the prehistoric sites in Sind. While stationed at Calcutta he did not ignore field work, and carried out further excavations at various sites, such as Lauriya-Nandangarh (Champaran Dist.), Kosam (Allahabad Dist.), Durgapur (Burdwan Dist.) besides several archaeological sites in Bengal.

OBITUARY

During his tenure as Officer-in Charge of the Archaeological Section of the Indian Museum, Calcutta, he entirely re-arranged the prehistoric gallery in the Museum, and in addition to re-organising other galleries he published two valuable guides, one dealing with sculptures of the early schools and the other on the Gandhara sculptures. In addition he deciphered and edited a large number of Brahmi and Kharoshthi inscriptions which have thrown considerable light on various complicated problems of Indian History.

The above short account leaves no doubt of Mr Majumdar's high scholastic achievements and great interests in all branches of Indian Archaeology. He devoted the same meticulous care to every branch which interested him, and his painstaking studies have left a mark in every line of work he took up. Archaeology in India is much the poorer by his tragic and early death.

Most of his earlier work was published in the *Indian Antiquary* and *Epigraphia Indica*, while his famous memoir "Explorations in Sind" was published as *Memoir No. 48* of the Archaeological Survey of India. A valuable note on the Copper Coins from the Stupa area was published in *Mohenjo-daro and the Indus Civilization* and a chapter dealing with the inscriptions of Sanchi is being published in the "Monuments of Sanchi." Another valuable contribution on prehistoric and protohistoric civilizations forms a chapter in *Revealing India's Past* which forms one of the India Society's publications, now in the press. In addition, a large number of his papers dealing with Brahmi Kharoshthi and later inscriptions were published in *Epigraphia Indica*.

Mr Majumdar had a very pleasing personality and was always ready to render any help to other workers and scholars. He was elected the President of the History Section of the Prabasi Vanga Sahitya Sammilan held at Patna in December 1937. He was a Fellow of the Royal Asiatic Society of Bengal and was the youngest Fellow to enjoy this great honour. In closing this notice we extend our sincere sympathies to Mrs Majumdar, and the three young children, two daughters and one son, in their heavy and irreparable loss.*

B. P.

*The writer is indebted for details of Mr Majumdar's life and work to Mr T. N. Ramchandran of the Archaeological Survey of India.

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Industrial India

We need not make any apology for reverting to the subject of the Industrial Regeneration of India on the eve of the Lahore session of the Indian Science Congress. The new constitution has transferred certain hitherto reserved powers to popular control and direction and it is but natural that the people of the country should look up to the new administrators for making planned efforts for the development of industries.

We are happy to note that the Ministers of Industries in the various Provinces are busying themselves with the question of devising ways and means for the development of industries. As announced in our " Science in Industry " section of the December number, the Government of Bengal has recently appointed an Industrial Survey Committee with the object of examining the position and suggesting the possible development of large and medium-sized industries in the province. The Bihar Government has already appointed four sub-committees to devise ways and means for development of industries in that province. The Indian National Congress—the Working Committee of which controls the administrative policy in seven of the major provinces of India has also appointed a National Planning Committee with a view to enquire and report on the possibilities of the development of " Mother " Industries as well as of Cottage Industries. A brochure, lying before us, " *On the Prospects of Industrialization in India* " by the Hon'ble Mr N. R. Sarker, Finance Minister to the Government of Bengal, shows that the thoughtful section of the intelligentsia of our country is also devoting attention to this urgent problem. Mr Sarker, before he joined the Bengal Ministry, was a wellknown businessman in the city of Calcutta and had been responsible for the growth and development of one of the biggest Insurance Companies in the East. His thoughtful articles on economic, agricultural and industrial problems of Bengal are well-known and, as such, his opinion on the question of industrialization is worth serious consideration. Mr Sarker, in common with the sponsors of the National Planning Committee of the Indian National Congress and of the Survey Committee of the Government of Bengal, lays stress, in the first instance, on the urgent necessity of instituting a thorough enquiry into the existing state of affairs. India is still predominantly an agricultural country

with 70% of her population maintained by the cultivation of the soil, and another 19% dependent in various ways, as landlords, village bankers, and their employees on agriculture. According to modern economists, land should not be burdened with more than 50% of population, and even in Poland, industrially the most backward country in Europe, about 60% of population is on land to India's 89 per cent. India is so backward industrially that almost anything from a pin to a locomotive may be suggested as an article for manufacture in India. Mr Sarkar rightly says that we cannot manufacture them all or at least not all at once. It is necessary that we should choose those which we consider essential as basic industries and also for which facilities from the point of view of supply of raw materials and ready marketing are available. Only a thorough industrial survey of the country can supply us with reliable data regarding these points. We are glad to note that the terms of reference of the two above-mentioned committees include in their programme scheme for such enquiries; to be ideal these enquiries should be carried out on an all-India basis, for India is one economic unit. The committee constituted as they are not ideally so. We are glad, however, to be informed that the Planning Committee of the Indian National Congress is seeking, and has already been able to secure the help and co-operation of non-Congress provinces and of Indian States.

We note from the programme published by the National Planning Committee that the industries as given in the list appended at the end, have been included in the category of "Mother" Industries regarding which the Committee is expected to formulate schemes.

We have to consider first the industries which are connected with power generation and power supply. It is evident that supply and availibility of cheap power are vital factors for the growth of industries. The extreme backwardness of cheap power supply in this country may be gauged from the fact that in India the consumption of energy is only about 100 units per head per year (and most of this is derived from man power) while the corresponding figure in European countries is about 1800 units. Not only is power undeveloped, but price of power is nearly four times larger than in other countries with the result that industries cannot grow.

Enquiry is also to be made on the manufacture of machines, machine tools, etc. The need of this enquiry is obvious. In case of interruption of communication with forejgn countries due to war or to any other causes, import of all machineries will cease and with that will inevitably come the collapse of the manufacturing industries of the country which are always dependent on the regular supply of necessary machineries. Some people are of opinion that high class machinery cannot be manufactured in India in the near future. But this is a mistake. There is no dearth of raw materials (mostly iron and steel) and no lack of men of the foreman class. The various ordnance factories of Government of India manufacture guns and munitions with the aid of Indian craftsmen, under the supervision of European engineers. Machineries for the manufacture of textiles, jute fabric and sugar have also been manufactured in India entirely by Indian workmen under Indian management. With State aid, all these factories may be multiplied to produce machines of economic utility not hitherto produced. Further, to increase technical efficiency, we require a good standardization laboratory.

Next there are the other key industries on which the National Planning Committee is also asked to enquire and report They are Fuel Industry, Metal Production and Chemical Industry.

Fuel resources, *viz.*, coal, oil or other fuels that may be utilized for different purposes of our country have not been properly investigated and it is at present mainly controlled by outside capital. The household fuels and industrial fuels and its several bye products leading to the materials for dye-stuffs and organic chemicals should be considered by an organisation to be set up by this board.

Metals are absolutely essential in the modern age for manufacture of all kinds of machinery Metals may be divided into two categories--ferrous and non-ferrous (all metals except iron like aluminium, copper, tin, magnesium, lead, zinc, tungsten etc.).

At present, owing to the low economic standard the consumption of metals in India is extremely

'Mother' Industries and Accessories

1. **Power** .. Electrical ..
   - Hydro-Electric.
   - Thermal.

2. **Fuel** ..
   - Coal ..
     - Distillation Products—Gas and Low boiling portions.
     - Steam Engines and Turbines.
     - Furnaces and Metallurgical Processes.
   - Oil .. .. Oil Engines.
   - Trade Waste .. .. Alcohol.
   - Wood

3. **Metal** ..
   - Ferrous ..
     - Cast Iron
     - Wrought Iron
     - Steel
     - Alloy Steel
     - Ferro Alloys
       - Modern Engineering Practice,
       - Specially Automobiles,
       - Aircrafts and Armaments.
   - Non-Ferrous (Base) .. Aluminium, Lead, Copper, Zinc, Manganese, Tungsten, Nickel, Chromium, Magnesium, etc.
   - Non Ferrous (Noble) .. Gold, Silver, Platinum, and Alloys.

4. **Machines** ..
   - Power Machinery ..
     - Steam Engines.
     - Turbines.
     - Generators.
     - Diesel Oil and Petrol Engines.
     - Industrial Alcohol Engines.
   - Engineering Machinery ..
     - Locomotive
     - Automobile
     - Aircraft
     - Industrial
       - Textile.
       - Sugar.
       - Paper.
       - Mining.

5. **Machine Tools** ..
   - High and Low Speed Tools.
   - Lathes, Drilling Machines, Shearing Machines.
   - Machine Shop Practice.

6. **Instruments** .. (Measuring).
   - Commercial and Industrial .. Pressure Gauges, Weighing Machines, Pyrometers, Automatic Controls, etc.
   - Standard (Precision) .. Attachments to various pieces of Armaments and Aircrafts, Range Finders and Geometrical Boxes, and Scientific Appliances.

7. **Chemical** ..
   - Heavy Chemicals ..
     - Sulphuric Acid.
     - Caustic Soda.
     - Soda Ash.
     - Bleaching Agents.
     - Ammonia, Nitric Acid, Urea.
     - Dyes, Colours.
     - Chemicals for Warfare.
   - Light Chemicals .. Small Industrial uses, Medical Preparations and Household uses.
   - Fertilisers.
   - Synthetic Products ..
     - Artificial Silks, Nitrocellulose.
     - Synthetic Rubber.
     - Plastics

8(*a*) TRANSPORT AND	Railway	Locomotives, Wagons, Carriages. Track, Bridges. Signalling Materials.	
	Waterway	Ships	Steam. Oil.
		Launches. Dredgers. Port and Harbour Equipments.	
	Airway	Air Ships. Flying Boats.	
8(*b*) COMMUNICATION	Electrical	Telegraph. Telephone. Radio.	

For the 'Nursing' of the above Industries

A. TECHNICAL EDUCATION.	Engineering Colleges	Engineers. Designers.
	Technical Schools	Foreman. Superiors.
	Workers' Schools	To train the Industrial workers—compulsory training i Drawing, Lathe working and in Graduation work o at least one Precision Instrument.
B. TECHNICAL RESEARCH AND PROPAGANDA.	Research Laboratories and Institutes	Pilot Plant Sections.
	Departments of Invention and Rationalisation	Standardisation of Machines and Instruments.

small. If India is to raise her economic level, the production of metals must be increased 10 to 12 times. India is fortunate in possessing minerals of all types, but excepting iron and to some extent copper, very few other metals have been properly worked. There is enormous scope for organised extraction and utilisation of the metals.

The key industries for the manufacture of essential chemicals: artificial fertilisers, sulphuric acid alkalis, bleaching materials, drugs, and the industry of ceramics including glass, and of rubber and rubber goods are all full of huge prospects. The need for planning and organisation in this line has been emphasised in recent articles by Sir P. C. Ray and Prof. S. S. Bhatnagar.

The Transport and Communication Industry which includes railway, steam navigation, road transport, and electrical communication is at present in a backward state compared to other countries and many essential articles have to be imported from outside.

We have attempted here to stress, briefly, on the pressing needs of the country and their solution by organisation of well-planned industries. We recommend to the Congress Planning Committee that enquiry into schemes on the above headings should be set up. The objective should never be lost sight of. Firstly, they should realize that the only way of fighting the appalling poverty of our country is to develop her industrially and secondly that only an industrialized India can protect herself from and also can fight against foreign aggression.

There is one aspect of the question of industrialization to which reference ought to be made here. It is not infrequently stated by many so called well wishers of the country that India should always remain agricultural and that instead of trying to develop herself industrially along Western lines, she should turn her attention to villages and remain in that state of placid contentment in which she had been for centuries. This doctrine cannot be too strongly condemned. The upholders of this doctrine perhaps honestly believe what they preach. They have perhaps been led to the view by the apparent evil effects of mechanisation and consequent degradation of the workers. But they seem to overlook the fact that the social dislocation, if any, is not due to introduction of machinery but is the result of capitalists utilising the scientific discoveries of the age for their personal gain. To obviate this, it is sometimes suggested that all industries should be under the direct control of the State and the example of Russia is quoted. This, however, is neither necessary nor possible. What is suitable for this country is a judicious division of the control of the industries between the State and the private individual, as in Japan and Germany, and to a certain extent in England even. The key or " Mother " industries should and ought always to remain in the hands of the State. They should always be national concerns. Industries subordinate to the key industries may be left to private enterprise.

We would conclude this article on the industrialization of India with the following remarks of Lord Stamp made in his Presidential address delivered to the British Association for the Advancement of Science at Blackpool in 1936.

•" Scientists see very clearly how, if politicians were more intelligent, if businessmen were disinterested, and had more social responsibility, if governments were fearless, far-sighted, and flexible, our knowledge could be more fully and quickly used to the great advantage of the standard of the life and health. ..It obviously involves very considerable alterations in the structure and objectives of society and in the occupations and pre-occupations of its individuals."

We are glad to note that the Congress President, Mr Subhas Chandra Bose has recommended practically the same measures as reported in this editorial in his opening address to the first meeting of National Planning Committee, held at Bombay on December 17, 1938. Ed. Sc. & *Cul.*

The Zoogeography of India in the Light of Herpetological Studies

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Introduction

MODERN Zoogeography, concerned as it is with the accumulation and interpretation of the data of animal distribution at the present day, is divided into two branches: firstly, *Ecological Zoogeography*, developed principally by Professor Richard Hesse (1924),[1] although foreshadowed by Semper (1881),[2] Adams (1909)[3] Shelford (1911)[4] and others; secondly, *Historical* or *Classical Zoogeography*, the branch that owed so much to the monumental work of Wallace (1876)[5] and was later dealt with by Heilprin (1894),[6] Beddard (1895),[7] Lydekker, Newbigin (1913),[8] etc. The former branch deals with studies in animal ecology as applied to distribution on a world wide scale. It investigates the relation of animals to their habitat, their adaptation to particular environments, and their dependence on the various conditions in their native regions. It is 'Animal Ecology' in another form, and has little to do primarily with the geographic location of the particular environment under consideration. To the student of this branch, for example, it is hardly of consequence whether a fossorial animal lives in America, Africa, or India, as long as the conditions for its burrowing life are the same. What matters is a careful study of environmental units (*niches* or *biotopes*) on the one hand, and the influence of these on the animals inhabiting them (*biocoenoses*) on the other. "The anatomical and physiological characters which fit 'an animal' to its surroundings, and enable it to compete successfully in the struggle for existence; the peculiarities due to the direct influence of the surroundings; and the reasons for its failure to spread into other environments"[9] are some of the subjects investigated. Such studies naturally tend to throw light on what we call '*Convergent Evolution*'; namely, how during the course of ages, phylogenetically different kinds of animals come to resemble each other on account of similar requirements in their habit and life.

The second branch of zoogeography, the *Historical* or *Classical*, studies the geographic distribution of animals on the face of the world, and tries to interpret it on the basis of past distributions. It deals with the present-day location of all forms of animal life (*faunal exploration*), classifies the world into various subdivisions (*regions* and *subregions*) on the basis of animal distribution, and attempts to explain the similarity or difference between the animals of one area and another in view of the evolution of animals on one hand, and of the physical features of the earth on the other. Granted that a particular kind of animal evolved at a certain place (Osborn's *Centre of Radiation*), it would gradually spread to adjoining areas (*dispersal* or *radiation*) as it grew in numbers. The more sharply

[1] *Tiergeographie auf oekologischer Grundlage*, 1924.

[2] *Animal Life as Affected by the Natural Conditions of Existence*, 1881.

[3] Isle Royale as a Biotic Environment, *Mich. Geol. Survey*, 1909.

[4] "Physiological Animal Geography," *Jour. Morph.*, 1911.

[5] Wallace, A. R., *The Geographical Distribution of Animals*, *1* and *2*. London, 1876.

[6] Heilprin, Angelo, *The Geographical and Geological Distribution of Animals*. London, 1894.

[7] Beddard, Frank E., *A Text-book of Zoogeography*. Cambridge, 1895.

[8] Newbigin, M. I. *Animal Geography. The Faunas of the Natural Regions of the Globe*. Oxford, 1913.

[9] This quotation is from Hesse, Allee, and Schmidt's *Ecological Animal Geography*, New York, 1937, p. 7.

is a region bounded on all sides by obstacles (*barriers*) to spreading (*isolution*), the more will its animal life be peculiar t oitself (*endemic fauna*), being different from adjacent regions. In case where an animal form is wide-spread, it is possible that the succeeding ages usher in such an altered condition of the physical features of the world that the species dies off from certain places, thereby leading to scattered distributions on the face of the globe (*discontinuous distribution*). Thus this branch of zoogeography tries to unravel the distributional histories of phylogenetically related kinds of animal life—in other words, what have been called "the homologies of animal distribution."[10]

If we leave aside ecological zoogeography, with which we are not directly concerned in the present article, we can divide the zoogeography of India into the following three enquiries:

(*a*) The division of the country into faunal subregions.

(*b*) The relation of the Indian fauna to that of foreign countries.

(*c*) The question of origin of the Indian fauna, and the interpretation of the present zoogeography of India in the light of past geological history.

It is clear that all groups of animals cannot have the same importance in these enquiries. Animals like birds and mammals, which came into existence rather late in the world's history, cannot have been affected by so many vicissitudes in the configuration of land and water, as well as in climate, as such cold blooded creatures of long standing as amphibians and reptiles. The more ancient a group of animals is, the more complicated is its distributional history. Environment and organism have always been very closely connected to each other, and our great ignorance about the past geography of the world enshrouds even our best zoogeographic conclusions in a mist of vagueness and uncertainty.

[10] Hesse, Allee, and Schmidt, *op. cit.*, p. 4

General Considerations

The importance of a group of animals for zoogeographic conclusions depends, to a large extent, on the facilities for dispersal it has, and on the kind of barriers that lie in its way. Assuming that the species has arisen at a certain spot and has had long enough time for spreading, its extension to other regions of the world will be due to its capacity for dispersal. Physical barriers, climate,[11] ecological factors, animal and plant competitions, biological controls all are important factors; and as a consequence, the interpretation of distributional data is an extremely complicated affair. Rensch[12] thinks that there is hardly an ecological investigation, which is not important in some way for the zoogeographer, and such a view is now generally held by zoologists. It goes without saying that Animal Ecology is but a young science, and that many facts about the distribution of animals in space and time will become clear to us, only when we know more definitely about their intimate relations to the environment.

Generally speaking, most amphibians and reptiles have few facilities for dispersal. Harrison,[13] in his discussion of the distribution of lizards, points out that "as a group they are not subject to haphazard distribution, as is so commonly supposed, but appear to require land connections or at least close approximation of land masses."[14] Smith says, "Apart from the Geckoes, ...it is rare for a species to be transported and to establish itself at any great distance from its native habitat, and where this has happened the fact can usually be recognised."[15] Snakes, although many of them can swim fairly well, are regarded (with the exception of marine forms) "as incapable of passing oceanic

[11] Hume (*Stray Feathers*, 7, pp. 53 and 501, 1878), to cite one example, calls attention to the influence of rainfall on the distribution of Indian Birds.

[12] Rensch, Bernhard, "Tiergeographie," *Fortschr. d. Zool.*, N. F., *1*, p. 249, 1937.

[13] Harrison, L., *Rept. Aust. Assoc. Adv. Sci.*, 1926.

[14] Harrison's view quoted from Nicholls, *Rept. Aust. and New Zeal. Assoc. Adv. Sci.*, *21*, 104, 1933.

[15] Smith, Malcolm A., "Reptilia and Amphibia, Vol. I, Loricata, Testudines," *Fauna of British India, including Ceylon and Burma*, London, p. 15, 1931.

barriers as are quadrupeds.''[16] A preponderating majority of amphibians cannot survive immersion in salt water, and their fortuitous dispersal by aquatic birds, which may carry the eggs attached to their feet from one place to another, is regarded as highly improbable.[17] Crocodiles are virtually aquatic in their habits, and to some extent like fishes, must require water connections for their extension. Barring only a limited number of forms, deserts or dry stretches of land act as efficient barriers to amphibians and reptiles, and so also lofty ranges of mountains. Most species of lizards show fidelity to their particular localities; few amphibians wander to any great extent; many chelonians do not show great migratory capacities; and the burrowing forms can be hardly expected to undertake themselves extensive journeys.

Against these limited capacities of amphibians and reptiles for active[18] modes of dispersal, however, we have to set over various possibilities for passive transportation, as well as the great geological ages during which dissemination might have taken place. Hurricanes,[19] storms, driftwood,,[20] shipments,[20] inadvertent transport by man,[20] birds and other animals, and many other similar agencies may have to be considered carefully in this connection. These factors, however, have already been dealt with by many workers at length.

Everything considered, it is apparent that *the discontinuous distribution of those species at present, which have extremely limited or practically no powers of active dispersal, are physiologically incapable of withstanding immerision in sea-water and therefore of crossing marine barriers, and are viviparous or ovoviviparous (so that the question of transport of eggs does not arise), provides most valuable data for a zoogeographer.*

Although few species of animals fulfil all these conditions fully, there are certainly some which approach the ideal very nearly. As an example, one may cite the distribution of allied, *purely freshwater*[21] fishes in widely separated areas. *Either* we have to suppose (as some authorities[22] have done) that the present-day fresh-water genera were formerly capable of passing through seas, *or* we may conclude that the land areas in question were formerly connected with each other (either through land-bridges or by actual apposition) ,and had connected water-courses. Many amphibians, burrowing snakes, lizards and the like have similar importance in this connection. It cannot, however, be said too strongly that no zoogeographical conclusions, based on a single group of animals, should be regarded as anything more than merely suggestive, and that it is necessary to consider the distribution of as many groups of animals as possible carefully (as Nicholls[23] has done so admirably for Australia) before assuming our deductions to be safely established.

Difficulties in Collecting and Interpreting Data

The present day instability in taxonomy, the paucity of phylogenetic knowledge and the inadequacy of faunal exploration all present serious difficulties to the student of zoogeography. The nomenclature of species and genera is in a state of constant flux, and what one author regards as the valid name for a particular form, another relegates to synonymy. The limitations of genera, species and subspecies are yet to be defined to the satisfaction

[16] Heilprin, A., *op. cit.*, p. 45.

[17] Smith, M. A., *op. cit.*, p. 15., *Cf.* Hora, *Curr. Sci.*, p. 351, 1937, for a similar remark about fresh-water fishes.

[18] Cott (*Proc. Zool. Soc.*, London, 2, 1159, 1926), gives examples of adult grogs' leaping from great heights, and Noble (1931) thinks that '' it is not improbable that they could make an aerial trip successfully.''

[19] Visher, S. S., '' Tropical cyclones and the dispersal of life from island to island in the Pacific,'' *Ann. Rep. Smithson. Inst.*, 313-319, 1925.

[20] *Cf.* Smith, *op. cit.*, p. 15.

[21] *i.e.*, neither anadromous, nor catadromous (*vide* Hora, *Curr. Sci.*, p. 351, 1937).

[22] Heilprin, Darwin, etc. Hora (*op. cit.*) takes no cognizance of this possibility. An interesting view is propounded in this respect by Macfarlane ('' The Evolution and Distribution of Fishes,'' New York, 1923), who thinks that instead of a change from marine to fresh-water habitat, fishes first evolved in freshwater areas, and later spread to seas.

[23] Nicholls, G. E., '' The composition and biogeographical relations of the fauna of Western Australia,'' *Rept. Aust and New Zeal. Assoc. Adv. Sci.*, 21.

of all, and each year brings in new proposals. In many important cases, we can hardly be sure whether a group of animals should be regarded as genetically homogeneous or merely as a polyphyletic assemblage. The question of 'Convergent Evolution' *versus* 'Common Origin' throws a shade of doubt over much of what we may deduce, and it is fairly certain that many species, apparently limited in range according to our present knowledge, will be found, on further investigations, to be more widely distributed. In view of these difficulties, as Nicholls[24] so aptly points out, even the mere listing of named forms proves, in itself, to be an undertaking of considerable magnitude and the further attempt to make the census reasonably exact by tracking down synonymies and changes in nomenclature is a task demanding the co-operation of a team of specialists.

While the collection of relevant facts in ample abundance and their proper evaluation present many a pitfall for the zoogeographer, the correct interpretation of the data is a veritable quicksand for all but the most wary. On one hand, the proverbial imperfection of the geological record, coupled with the insufficiency of palaeontological investigations, lets us down in a majority of cases where help from these directions would be most welcome. On the other, the palaeogeographic findings about which we can be reasonably sure, are despairingly limited in number. Palaeogeographic maps are based on geological and palaeontological as well as zoogeographic evidence, but these three elements are of very unequal value. The geologic evidence of the existence and extent of former seas, which have left their deposits in areas now continental, is most certain. Land connections, deduced from the correlation of stratified rocks in areas now separated by seas, are less convincing. Palaeontology, from the identity of differentiation of fossil faunae, is able to conclude with a high degree of probability on the nature of the contemporary connections or separations. The data of palaeontology, however, are for the most part meagre, so that only rarely, as in the question of the former connection of North America and Eurasia, is this kind of evidence fully available. The principal and often the only source of evidence for the existence of former land connections remains in the data of zoogeography, but this evidence is least reliable and becomes progressively less useful as the period of the supposed connection becomes remote. As accessory evidence, to support and illustrate the conclusions of geology and palaeontology, especially with regard to geologically recent changes, the phenomena of animal distribution have a high value. When employed alone, they are of doubtful importance and even a large amount of evidence must be interpreted carefully and critically.

"Such critical care has only too often been wanting, and this field of zoogeography has become a clearing-house for fantastic combinations. From Forbes to von Ihering and Scharff, the tendency to explain facts of animal and plant distribution by assuming the presence of land bridges has been uncontrolled. The unbridled hypotheses concerning the rise, displacement, and connection of land masses have left scarcely a spot which has not at some time been involved in a land bridge. In spite of the repeated warning of conservative investigators, some zoogeographers continue to 'make continents as easily as a cook makes pancakes' (Darwin)."[25, 26]

Faunal Sub-regions of the Indian Empire

As already pointed out, different groups of animals have different values for the establishment of zoogeographical subdivisions of a country, and it often happens that the faunal subregions as deduced from the study of one group of animals do not fully coincide with those deduced from that of another. The time of origin of a particular kind of animal is an important consideration in this connection, as a form originated in the far distant past would have been affected by considerably many more physiographic changes in the world than one of much later origin. Animals more adapted for surmounting barriers of various kinds are naturally more widespread; for the same reason, they are not very important zoogeographically. The same barrier may

[24] Nicholls, *op. cit.*, p. 93.

[25] Darwin, F., *Life and Letters of Charles Darwin*, I, p. 431; 2, p. 219, 1888.

[26] Hesse, Allee and Schmidt, *op. cit.*, pp. 105-106

THE ZOOGEOGRAPHY OF INDIA IN THE LIGHT OF HERPETOLOGICAL STUDIES

have different values for different animals, and the climatic and ecologic factors vary so widely that what applies to one group of animals does not, to the same extent, apply to another. It is clear, however, that amphibians and reptiles, being more ancient than birds and mammals, geologically speaking, are naturally more important for many zoogeographic considerations. The inability of the amphibia to withstand salt water[27] is a significant fact, and in most cases the efficiency of the marine barrier against their dispersal is incontrovertible. While the distribution of fishes can be generally utilized for drawing conclusions about the past history of various water-courses, fishes being principally limited to aquatic habitats, the distribution of most amphibians and reptiles throws a valuable light on the changes undergone by continental land masses during the geological ages.

If we set aside brief references to the distribution of Indian amphibians and reptiles by such classical zoogeographers as Wallace, Heilprin, Beddard and others, Blanford (1901)[28] appears to be the first to have studied these two groups (along with other classes of vertebrates) intensively from the zoogeographical standpoint. He divided, for the sake of this study, the Indian Empire (*i.e.*, the whole of India, Ceylon and Burma) into 19 tracts (Fig. 1) on the basis of such physical features as "rainfall, temperature, the presence or absence of forest, prevalence of hilly ground, and, in some cases, elevation above the sea."[29] He had also been guided by his own knowledge of the country and by observations on the range of particular species.

Blanford tabulated all the vertebrate genera, known at his time, in these tracts, compared and contrasted the fauna of one tract with the other, and finally reached conclusions as to the proper zoogeographic divisions of the Indian Empire. He lays special emphasis on the importance of the distribution of *genera* in such a study, and says:

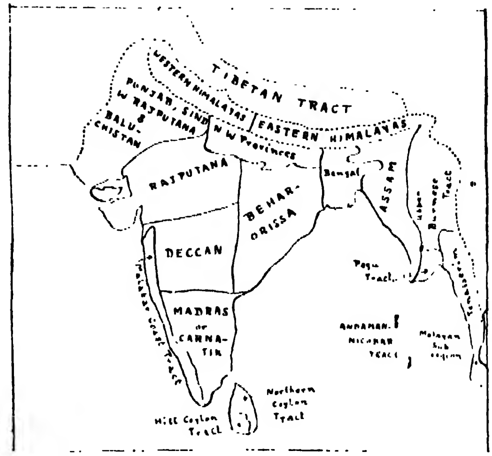

FIG. 1

Blanford's tracts for the Zoogeographic study of India

"After some consideration I have come to the conclusion that the object in view can be best carried out by a review of the distribution of genera, families and subfamilies alone being too numerous and too unequal in importance."[30]

As a result of these studies, Blanford divides the Indian Empire into the following five zoogeographical subregions (Fig. 2), more or less sharply marked off from each other:

(1) *Part of the Eremian Subregion of the Holarctic Region.* The Punjab, Sind, Western Rajputana and Baluchistan, according to Blanford, should be removed from the Indo-Malay (more often called Oriental)[31] Region. These represent the South Eastern extremity of the Eremian (Tyrrhenian or Mediterranean) Subregion of the Holarctic Region

[27] In other words, amphibians are influenced by slight changes in salt content; *i.e.*, they are *stenohaline*. For a discussion of salinity in relation to various kinds of animals, see Chap. 11 of Hesse, Allee and Schmidt, *op. cit.*

[28] Blanford, W. T., "Distribution of Vertebrate Animals in India, Ceylon, and Burma," *Phil. Trans. Roy. Soc.*, London 1901. *Cf.* also his article "Zoogeographical divisions of India, based to a great extent on a study of the distribution of land mollusca," *Jour. Asiat. Soc. Bengal*, 39, pt. 2, p. 336, 1870.

[29] Blanford, W. T., *op. cit.*, p. 343.

[30] Blanford, W. T., *op. cit.*, p. 336.

[31] Blanford prefers to call this region *Indo-Malay*, and the reason given by him is that "the name 'Oriental,' substituted for 'Indian' by Wallace, has unfortunately long been used by botanists for South-western Asia and Persia. The best name for the 'Eastern Palaeotropical Region,' as it is called by some writers, is probably that employed by Elwes—'Indo Malay'." (Blanford's article, footnote on p. 337).

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(2) *The Tibetan Subregion of the Holarctic Region.* This subregion consists of the Himalayas above forest range and of such portions of Tibet as come within the Indian political limits. The fauna of this division is entirely that of Central Asia, and thus belongs to the Holarctic (Palaearctic) not the Indo-Malay-- Region.

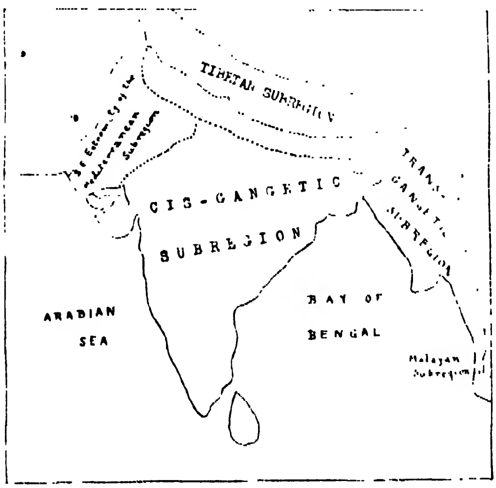

FIG. 2.
Blanford's Zoogeographic subregions of India.

(3) *The Cis-gangetic Subregion.* This extends from the base of the Himalayas to Cape Comorin, and from the Arabian Sea and the eastern boundary of the Punjab area to the Bay of Bengal and the hills forming the eastern limit of the Gangetic alluvium; it also includes Ceylon. The forests of the Sahyádri Range and of the western or Concan and the Malabar coasts, as also the hill area of Southern Ceylon are far richer in vertebrate genera than the remaining area, but according to Blanford, are not sufficiently distinct to require subregional separation.

(4) *The Trans-gangetic Subregion.* This consists of the forest area of the Himalayas, Assam, Burma except South Tenasserim), Southern China, Tonquin, Siam and Cambodia.

(5) *The Malayan Subregion.* South Tenasserim agrees best with the Malay Peninsula and should be included in the Malayan Subregion of the Oriental Region

The *Andaman Islands* have an impoverished Burmese fauna, and the fauna of the *Nicobar Islands* approximates more to Sumatran types.

Thus according to Blanford, the continental area of the *Oriental* or *Indo-Malay Region* should be divided into three subregions the *Cis-gangetic*, the *Trans-gangetic*, and the *Malayan*. Of these, the *Cis-gangetic Sub-region* is by far the largest, and comprises the major part of the Indian Empire. Blanford does not divide this large area into smaller divisions, and the reason is that he relies almost exclusively on the distribution of *genera* alone. A scrutiny of the distributions of the amphibian and the reptilian *species*, however, makes it possible also to recognize smaller subdivisions in the *Cis-gangetic Sub-Region.*

After Blanford (1901), as far as herpetological data are concerned, the only comprehensive attempt to divide the Indian Empire into zoogeographical subdivisions is that by Malcolm Smith (1931),[32] who points out that " the distribution of many of the genera as given by " Blanford " has been shown to be erroneous, due to incorrect determinations."[33] Smith's account and map of the zoogeographical divisions of the Indian and the Indo Chinese Sub-regions is very valuable indeed, but it does suffer to some extent by his omission of the relevant data in support of it. One readily notes several differences between Blanford (Fig. 2) and Smith (Fig.3).

In the first place, Smith feels and his view is fully justified by the facts that the fauna of Siam, French Indo-China, and Southern China, is so closely allied to that of Burma that it would be scientifically incorrect to separate them from one another. " Together with Assam and the Eastern Himalayas," according to him, " they form a natural subregion, and it is only right that they should be considered as a whole."[34]

The inclusion of the country to the east of the Yomas in the same zoogeographic areas with that

[32] Smith, Malcolm A., " Reptilia and Amphibia, Vol. I, Loricata, Testudines." *Fauna of British India, including Ceylon and Burma*, London, p. 13-23, 1931.

[33] Smith, M. A., *op. cit.*, p. 15.

[34] Smith, M. A., *op. cit.*, p. 13.

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on their west is in such a marked contrast with some recent views expressed in connection with the phyto- and palaeo-geography of this area that we must allude to them here. On the one hand, Kingdon Ward (1935 and earlier papers)[35] believes, on the basis of modern flora, in an ***eastward*** continuation of the Himalayas from the North-Eastern corner of India right across China to the Pacific coast; on the other, Sahni (1935, 1936)[36,37] suggests that "the chain of the Himalayas is continued southwards round Assam into Burma and the Malayan are of Islands." The facts of present day amphibian and reptilian distribution lend no support to Sahni's view, and one fully agrees with Smith, when he says that "the complete change in the direction of the mountain ranges which occurs at the bend of the Dihang-Brahmaputra does not coincide with any change in the faunal characters, and in this respect Assam and the Eastern Himalayas cannot be separated."[38] Whilst the fauna of the northern parts of Burma differs definitely from the southern, one fails to observe any significant change within the same latitudes from east to west.

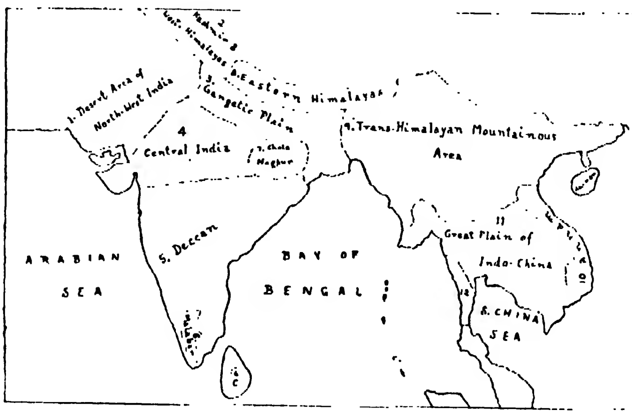

Fig. 2

Malcolm Smith's Zoogeographical areas of India

Secondly, Blanford's Cis-Gangetic Sub region is equivalent to five areas of Smith: *viz.*, (1) the Gangetic Plain, (2) Central India, (3) the Deccan, (4) the Mountains of the Malabar Tract and Ceylon, and (5) the Chota Nagpur Area. Some of these areas, at any rate, are hardly distinct from each other faunistically.

Thirdly, Blanford's Trans-Gengetic Sub-region equals three areas of Smith: *viz.*, (1) the Eastern Himalayas, (2) the Trans-Himalayan Mountainous Area (in part), and (3) the Great Plain of Indo-China (in part).

Fourthly, Smith recognizes Kashmir and the Western Himalayas as a separate zoogeographical area, while Blanford regarded it as part of the Trans-Gangetic Subregion.

For the last two years I have been engaged in carefully examining the distributions of amphibian and reptilian *species* found within the Oriental Region, and I have already made many tables to illustrate a rather ambitious work on the zoogeography of this part of the world. It is outside the scope of the present article to go into details; I might, however, mention a few facts regarding the zoogeographic division of the Indian Empire, which have emerged from my studies.

As has already been mentioned above, Blanford took the distributions of the *genera* as the basis for his zoogeographic study and did not take the ranges of the *species* into consideration. Naturally, his divisions (*i.e., subregions*), being based on genera, are rather large and can be further subdivided into smaller areas (called by me ***provinces***), characterized by *specific* fauna. I recognize the following ten provinces within the limits of the Indian Empire (Fig. 4):

(1) *The Arid or Semi-Arid Province of North-West India*, consisting of Baluchistan, the North-West Frontier Province, the Punjab, Western Rajputana as far as—or slightly farther than—the Aravalli range, the Peninsula of Cutch, and Sind. The distinctness of this division is recognized both by

[35] Ward, F. Kingdon, *Jour. Linn. Soc. Bot.*, 1935 (cited by Sahni, 1936).

[36] Sahni, B., "Permo-Carboniferous Life Provinces with Special Reference to India." *Current Science*, 4, pp. 385-390 1935.

[37] Sahni, B., "Wegener's Theory of Continental Drift in the Light of Palaeobotanical Evidence." *Jour. Ind. Bot. Soc.*, 15, pp. 319-332, 1936

[38] Smith, M. A., *op. cit.*, p. 22.

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• Blanford (1901) and Smith (1931). The rainfall is small, being from 0 to 20 inches annually, and the conditions are those of a desert or semi-desert. The fauna of this subregion is allied to that of the countries to the west of India (to Afghanistan, Persia, Arabia, etc.), and almost all the genera and species (with very few exceptions) are characteristic, being found nowhere else within the Indian Empire. We might mention, amongst lizards, the genera *Teratoscincus*, *Stenodactylus*, *Alsophylax*, *Agamura*, *Pristurus*, *Ptyodactylus*, *Scincus*, *Ophiomorus*, *Eremias*, *etc.*, and amongst Snakes, *Leptotyphlops* (syn. *Glauconia*), *Contia*, *Lytorhynchus*, *Tarbophis*, etc. Many species are endemic. Amphibians are rare, the only genera found being the cosmopolitan *Rana* and *Bufo*. *Bufo olivaceus* is endemic to Baluchistan, and so is *Rana Stenosignata*. Very few turtles occur in the rivers of this area, and none are endemic or peculiar to it.

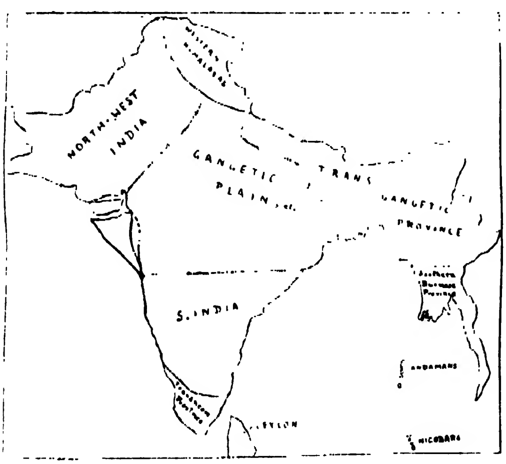

FIG. 1.
Zoogeographical Provinces of the Indian Empire according to Mahendra.

(2) *The Western Himalayas*, consisting of Kashmir, Simla, Kumaon, and Garhwal districts, adjacent mountainous regions of Western Tibet, Alpine Punjab, etc. The country is poor both in Amphibia and Reptilia. Its fauna, however, limited as it is, definitely differs from that of the Eastern Himalayas. I do not quite agree with Smith's remark that "the few species that are recorded from it are stragglers from the surrounding areas."[39] There are certainly some *endemic* species, characteristic of this division. One might mention *Gymnodactylus fasciolatus*, *Gymnodactylus lawderanus*, *Japalura major*, *Japalura kumaonensis*, *Phrynocephalus theobaldi*, and *Leiolopisma ladacense*.

(3) *The Transgangetic Province*, consisting of the northern parts of Bihar and Bengal, the whole of Assam, Burma approximately north of 20° latitude, Nepal, the Himalayas to the east of Nepal, and the country still eastward. This province is very nearly equal to two areas of Smith, *viz.*, to the Eastern Himalayas and the Trans-Himalayan Mountainous Area, and differs from Blanford's Trans-Gangetic Subregion by the non-inclusion of the Western Himalayas and the southern part of Burma (particularly, the Pegu District and Tenasserim). The herpetological fauna is both rich and characteristic. Amongst the endemic genera are *Ptyctolaemus*, *Mictopholis*, *Oriocalotes*, *Stoliczkaia*, *Tylotriton*, etc., and the endemic species are quite numerous.

(4) *Southern Burmese Province*, including Burma approximately south of 20° latitude. Species like *Gymnodactylus oldhami*, *G. consobrinoides*, *Draco taeniopleus*, *Goniocephalus lepiodogaster*, *Riopa anguina*, *Leiolepis belliana belliana*, *Bungarus flaviceps*, *Doliophis bivirgatus*, *Doliophis intestinalis*, *Ptyas tenasserimensis*, *Coluber melanurus*, etc., amongst Snakes; *Platysternum megacephalum*, *Trionyx cartilagineus*, *Morenia ocellata*, *Geoemyda grandis*, *Siebenrockiella crassicollis*, *Cuora amboinensis*, etc., amongst Turtles; *Kaloula macrodactyla*,[40] *Glyphoglossus molossus*,[41] *Calluella guttulata*, etc., amongst Amphibia are so characteristic of this division as to leave no doubt about its separation from the Trans-Gangetic Province.

(5) *The Gangetic Plain and the adjacent country as far south as 20° latitude.* The southern boundary is very vague and approximate; perhaps a straight line drawn from Bombay to Puri might be better, although even then it would not be faunistically precise. This province is a *negative* one, and cannot be defined by endemic fauna.[42] Its extreme poverty,

[39] Smith, M. A., *op. cit.*, p. 20.

[40] Parker (*A Monograph of the Frogs of the Family Microhylidae*, London, 1934) merges this species with *Kaloula pulchra*.

[41] The genus *Glyphoglossus* has only a single species.

[42] The rare snake *Elachistodon westermanni*, however, has so far been recorded only from Bengal.

as far as characteristic genera or species are concerned, is striking; and its recognition as a separate province is not on account of any faunal characteristics, but because it is otherwise impossible to give boundaries to the adjacent provinces. The southern boundary, although not sharply defined, is justified by the absence southwards of the common northern house-gecko *Hemidactylus flaviviridis*, of the crocodilian genus *Gavialis*, and of all the fresh-water turtles, except the species *Geomyda trijuga*, *Geoemyda silvatica* and *Testudo travancorica*. Similarly, the importance of this line lies also in delimiting, from the northern fauna, the characteristic peninsular forms so abundant in South India generally and in the Travancore region in particular. It is interesting to note that Northern India is very poor in amphibian fauna, having only five genera (*Rana*, *Rhacophorus*, *Microhyla*, *Uperadon*, and *Bufo*), while the South has so few fresh-water turtles.

Although we distinguish the Northern Plain of India, on the basis of terrestrial amphibians and reptiles, into three provinces an arid one in the north-west; a mountainous tract consisting of Assam, North Bengal, etc., in the east; and a non descript one, consisting of the Gangetic Plain and the adjoining country, in the middle the river fauna belonging to these groups is practically the same all along. The Indian *Gharial* (*Gavialis gangeticus*) ranges as much in the Indus System as in the Ganges and its tributaries, or in the Brahmaputra and the Mahanadi. The turtles also (*Kachuga tectum*, *Kachuga smithi*, *Hardella thurgi*, *Trionyx gangeticus*, etc.) give hardly any ground for distinguishing the Indus, Gangetic and Brahmaputra systems from each other.

Smith divides the area included in this zoogeographical province into three areas: the Gangetic Plain, Central India, and the Chota Nagpur Area. A careful scrutiny, however, of amphibian and reptilian distributions shows the insufficiency of the data in support of such a division. The only species worth mention are *Gekko gecko* (Bengal, Bihar, but also in the Andamans), *Hemidactylus gracilis* (S. E. Berar and Raipur in the C. P., as well as Bombay Presidency), *Agama minor* (C. P. and Central India to the Ganges Valley in the U. P. and westwards as far as Sind), Mabuya innotata (S. E. Berar; Koba, Bilaspur, C. P.), *Cabrita Jerdoni* (Northern and Central India: Agra (U. P.), Chanda, Bilaspur and Bhandara (C. P.), Udaipur and Jashpur, west of Chota Nagpur, Palkonda Hills, Godavari district, S. E. Berar), and perhaps a few others.

(6) *South India*[43] *below 20° latitude, excluding the Travancore Province*, as described below. The country roughly south of 20° latitude is faunistically distinct from that to its north. Included in the characteristic fauna of this province are *Riopa lineata*, *Barkudia insularis*, *Sepsophis punctatus*, *Ophisops beddomei*, *Gymnodactylus nebulosus*, *G. dekkanensis*, *G. albofasciatus*, *G. Jeyporensis*, *Calodactylus aureus*, *Hemidactylus subtriedrus* and *H. reticulatus*. Only a few wide-spread species of fresh-water turtles (*Geoemyda trijuga*, *Kachuga tectum*, *Testudo elegans* and *Lissemys punctata*) are found.

(7) *The Travancore Province*, consisting of the hilly country south of latitude 12° or 13° latitude on the west, and south of the Coleroon River in the east. The distinctness of this division is well recognised, the fauna being extremely rich in endemic forms. The number of characteristic genera and species is too large to be within the scope of the present article. The province, although differentiated adequately by many forms absent in Ceylon, has much in common with the Ceylonese Area

(8) *Ceylon.* Ceylon forms a distinct zoogeographical province, with clear affinities to the Tranvancore Subregion. For a detailed study of its herpetological fauna, one may refer to Sarasin's excellent paper on the history of the fauna of Ceylon.[44]

(9) *The Andaman Islands.* Besides having a few endemic forms which differentiate the fauna of this region as separate from others, the Andamans are faunistically allied to the Burmese Subregion on one hand, and to the Nicobars on the other. There are hardly any endemic genera, owing evidently to the fauna being imported from the continent in

[43] The Western Ghats and the adjoining country between 13° and 20° latitudes may be faunistically distinguished, to some extent, from the rest of South India.

[44] Sarasin, Fritz, "Über die Geschichte der Tierwelt von Ceylon," *Zool. Jahrb., Suppl., 12*, pp. 1-160, 1910.

comparatively recent times. The endemic species are *Gymnodactylus rubidus, Phelsuma andamanense, Calotes andamanensis, Mabuya tytleri, Leiolopisma macrotympanum, Typhlops andamanensis, Boiga andamanensis*, etc. There are no amphibians (except 2 species of *Rana*) and no fresh-water turtles.

(10) *The Nicobar Islands.* A great majority of the species found in these islands (*Goniocephalus subcristatus, Mabuya andamanensis, Lepidodactylus lugubris, Calotes mystaceus, Lygosoma maculatum, Oligodon woodmasoni, Trimeresurus cantoris*, etc.) are those that occur also in the Andamans, and it is very probable that the fauna of the Nicobars has been derived rather recently from the Andamans. The endemic species are few in number (*Mabuya rugifera, Calotes jubatus, Leiolopisma macrotis* and some others). As far as the amphibians and reptiles are concerned, I fail to find any support for Blanford's view that the fauna of the Nicobar Islands approximate to Sumatran types.

Resemblance of the South Indian Fauna to that of the Trans-Gangetic and the Burmese Provinces

As already pointed out by several previous authors on the zoogeography of India, a considerable number of vertebrates found within the Indian Empire afford examples of *discontinuous distribution* of a peculiar kind. On one hand, they occur in Ceylon and South India; on the other, they are found in Burma and the Indo-Malayan Area. Between these two distributions, there is a discontinuity in range, as the intervening tracts *viz.*, those of Northern India do not possess them. Many striking cases of this phenomenon have been mentioned in birds and mammals, but the same thing is true also in the case of amphibians and reptiles. Thus the ophidian genus *Cylindrophis* is found in Ceylon, Burma and Cochin China, Malay Peninsula and Archipelago, and Celebes; it is absent in North India and the Himalayas. The family *Xenopeltidae*, which comprises a single genus and species (*Xenopeltis unicolor*), occurs in Burma, Indo-China, Malay Peninsula and Archipelago, as well as in Trichinopoly in South India. The limbless amphibian *Ichthyophis* inhabits the mountains of Ceylon and Malabar, Eastern Himalayas, Khasi Hills, Burma, Siam, Malay Peninsula, Sumatra, Borneo and Java. Many other similar cases might be mentioned, illustrating this sort of discontinuity in distribution. Malcolm Smith (1935) says:

"The close affinity which certain Indo-Chinese and Malayan lizards have with others that inhabit Southern India the northern part of the Indian Peninsula being without them raises an interesting point in zoological distribution. The resemblance which *Dasia olivacea* bears to *D. subcaeruleum*, *Lygosoma maculatum* to *L. dussumieri*, and *Riopa bowringii* to *R. albopunctata*, is so close that one feels convinced that if one has not been derived from the other they must surely have had a common ancestor. The genus *Draco* has a similar distribution; *Varanus salvator* occurs in Ceylon and in Indo-China, but is absent from the whole of the Indian Peninsula; and there are similar parallels in distribution among the mammals, birds, fishes, and insects. Why are they absent from Northern India? Have they died out in that area, or was there at one time a more southern route across the Indian Ocean by which they could travel?"[6]

The first of these two alternatives suggested by Smith was utilized by Blanford to account for this anomaly in distribution. He believed in a migration of Himalayan vertebrates southwards during the Glacial epoch. Their absence in the greater parts of India proper, according to him, is largely due to the destruction of forest by man and domestic animals in tracts suitable for agriculture. We may quote the following passage from him to set forth his view:

"During the coldest portion of the Glacial epoch, a large part of the higher mountains must have been covered by snow and ice, and the tropical Indo-Malay fauna, which had occupied the range and which may have resembled that of the Indian Peninsula more than is the case at present, must have been driven to the base of the mountains or exterminated. The Holarctic forms apparently survived in larger numbers. The Assam Valley and the hill ranges to the southward would afford in damp, sheltered, forest-clad valleys and hillslopes a warmer refuge for the Indo-Malay fauna than the open plains of Northern India and the much drier hills of the country south of the Gangetic plain. The Indo-Malay types of the Peninsula generally must have been driven southwards, and some of them, such as *Loris* and *Tragulus*, which must originally have been in touch with their Burmese representatives, have never returned. It was probably during this cold period that the ossiferous Nerbudda beds and the deposits in the Karnul caves were accumulated. The tropical, damp-loving, Dravidian

[6] Smith, M. A., "Reptilia and Amphibia, Vol. II.—Sauria, *The Fauna of British India, including Ceylon and Burma*. London, pp. 15-16, 1935.

fauna, if it inhabited Northern India, must have been driven out of the country. Unless the temperature of India and Burma generally underwent a considerable diminution, it is not easy to understand how plants and animals of temperate Himalayan types succeeded in reaching the hills of Southern India and Ceylon, as well as those of Burma and the Malay Peninsula."[46]

Relation of the Indian Herpetological Fauna to that of Other Countries

Whilst a detailed discussion of the affinities of the Indian herpetological fauna to that of other countries is reserved for a separate article, some of the more salient facts may be mentioned here.

The Indian Empire, as related to other countries faunistically, can be regarded as a combination of three separate units, or *faunal centres,* almost completely independent of each other, being separated by the Gangetic Province. These faunal centres are (*a*) North West India, (*b*) South India, and (*c*) the Trans-Gangetic Province. A study of the faunae, belonging to these three centres, leaves no doubt about their separate derivations and affinities, and the otherwise zoogeographically unimportant province of the Gangetic Plain and the area south of it, effectually separates the one from the other.

The *raison d'etre* of the three faunal centres of India actually lies in the geological history of the country (Fig. 5). The stable and solid Southern Block, the Deccan Peninsula, consisting of ancient crystalline rocks, Cuddapahs and Vindhyans, and showing no appreciable marine deposits of a later age than Cambrian, is naturally expected to be rich in herpetological fauna of a more or less ancient derivation. The Indo Gangetic Plain, being of sub-Recent origin, has no amphibians or reptiles properly its own, and shows signs of having been gradually encroached upon from the two sides, east and west, by the faunae of adjacent regions. The North Western India, naturally, has been overrun by waves of immigrants from Asiatic countries to the west of India, and similarly the fauna of the North-Eastern India has been derived from that of the Far East. As far as India is concerned, many facts seem to show that the major part of the Amphibian

[46] Blanford, W. T., *op. cit.*, p. 435.

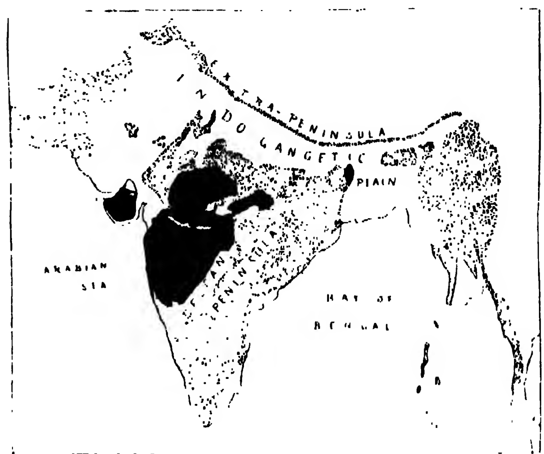

FIG. 5.

Main Geological Divisions of India, based on Wadia, Krishnan and Mukerjee's Soil Map (1935). The black colour shows the Deccan traps.

fauna is derived from some southern landmass, probably Africa, while the Chelonians have come from the Asiatic countries to the east of India. Lizards and snakes appear to have invaded, apparently, from all three sides.

More particularly, one might mention that North West India has many genera and species in common with Afghanistan, Persia, Transcaspia, and even North East Africa. The Eastern mountainous parts are faunistically allied to Siam, Indo-China, Annam, etc. The Malabar region and Ceylon shows some affinities to Africa; and the Malay Peninsula is definitely related in its herpetological fauna to Sumatra, Borneo and Java.*

* The author is indebted to his friend and colleague, Mr N. N. Ghose, Professor of Geography, for much valuable information and many helpful discussions, as well as to Dr Baini Prashad for the loan of books from the Indian Museum Library.

The Passage of Ionizing Particles Through Photographic Emulsions

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THE photographic plate has long been an indispensable tool in scientific research, indeed most of the remarkable advances of the past half century would have been almost impossible without it. Its action depends upon the remarkable properties of a small group of compounds, of which silver bromide is the most important, which are sensitive to the action of light. In the plate as customarily used, the silver bromide is present in a finely divided form, and is contained in a thin gelatine layer which is spread on the surface of the glass plate. It is this layer of gelatine, impregnated with silver bromide, which we call the ' emulsion ', and of course it may be spread on other surfaces than glass, as in the ordinary photographic film where the emulsion is spread on a flexible celluloid material.

The thickness of the emulsion varies according to the kind of plate, but about 20μ is a usual value ($1\mu = 1/1000$mm.). Again, the number of particles, or ' grains,' of sliver bromide varies greatly, but may easily exceed one hundred million on each square cm. of plate surface. The action of light on the plate (unless greatly prolonged) produces no observable chemical change in these grains, but it renders them unstable and therefore more susceptible than unexposed grains to chemical action. It can hardly be claimed that we have yet reached a complete understanding of this process, though it has been the subject of much research. When the plate is treated with a ' developer,' which is a weak reducing agent, the grains affected by light are reduced to metallic silver, and the others are not changed, but remain as silver bromide. ' Hypo ' (a solution of sodium thiosulphate) dissolves away the silver bromide, and in the final state the gelatine layer contains only the finely divided silver, the quantity of this at any point corresponding to the intensity of the light which acted at that point. The photographer speaks of such a plate as a ' negative '.

Light, however, is not the only agency which can bring about an instability of the grains. For example, a mechanical strain in the emulsion has this effect. If an ordinary plate is rubbed with the finger nail, a ' pressure mark ' is visible on the plate after development. Ionizing particles also have the power of making grains developable, and the first detailed study of this effect was made as early as 1910 by Kinoshita, who used the α particles from radioactive bodies.

The nature of the effect will be clear from the diagram (fig. 1). The oblique line represents the

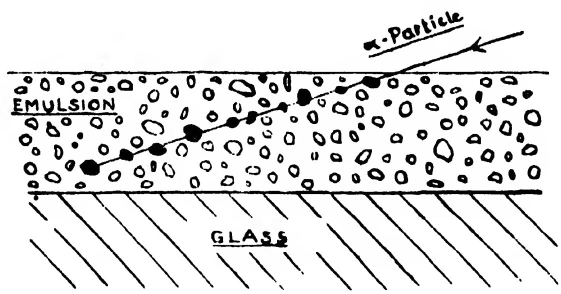

FIG. 1.

Mode of production of a track in a photographic emulsion.

track of an α particle which enters the emulsion at a small angle. The range of the α particle in the emulsion is less than 1/1000 of its range in air, but it may nevertheless travel far enough to encounter, and pass through, a number of grains. Each of these grains is made developable, and the others are not affected. When the plate is developed, there results a row of developed silver grains which mark out the path of the particle. Nothing is visible to

THE PASSAGE OF IONIZING PARTICLES THROUGH PHOTOGRAPHIC EMULSIONS

the naked eye, since the grains are so small, but under a high magnification the row of grains can be seen and the distance traversed by the particle can be measured.

One great drawback to this method of observing the tracks of ionizing particles has been that there are always a number of grains which are spontaneously developable, even though the plate has not been exposed in any way. Thus when the plate is examined under the microscope a large number of grains are seen scattered at random in the field of view, which make it very difficult to observe the tracks. In 1931 the research department of Messers Ilford, Ltd., made special experiments at my request, and were able to produce a special type of emulsion in which these background grains are practically absent. This emulsion has been of great service in subsequent work. Other workers, however, (chiefly Frl. Blau and her co-workers in Vienna) have obtained successful results with ordinary commercial emulsions. When the special emulsion is used, a magnification of about 900 times is required for convenient observation of the tracks.

Tracks are produced not only by α particles, but by other ionizing particles which have a sufficient range, such as swift protons. Electrons, however, do not give observable tracks, for an electron does not produce sufficient disturbance in its passage through a grain to render it developable. There are marked differences between the tracks of α particles and protons, chiefly due to the lower ionizing power of the latter. In the special emulsion a proton only makes a proportion of the grains which it encounters developable, so that along the track of the proton one sees fewer grains in a given length. This criterion often makes it possible to distinguish between the tracks of α-particles and protons.

This method of recording the tracks of ionizing particles has shown itself of value in several lines of research. One of the first applications of importance was the study of the swift protons which are produced when neutrons pass through matter containing hydrogen. A neutron has about the same mass as a proton, or hydrogen nucleus, so that in a head on collision practically all the energy of the neutron is given to the proton, which is knocked forward at high speed. Neutrons passing through the gelatine of the photographic plate may be expected to produce such swift protons, since the gelatine is largely composed of hydrogen. The tracks of these protons have been found, and several studies of them have been published. In the early days of the investigation of neutrons, before other methods had been developed, these studies of proton tracks threw some light on the energies of the neutrons emitted by beryllium when it is bombarded by α-particles. Thus in my experiments tracks of length exceeding 400μ were found, corresponding to a range of the particles in air of nearly 60 cm., for which neutrons having an energy of 6.6 million electron volts would be required. Frl. Blau has found tracks even longer than this. Thus it was shown that neutrons of high energy are present in the radiation from beryllium, but the method did not prove suitable for determining the distribution of energy amongst the neutrons.

A later development of the method was the recording of nuclear disintegrations produced by the passage of neutrons through matter. In two cases the method gave valuable information which was not available at the time by any other methods, namely the disintegration of boron and lithium. These reactions are now well known, and are written in the form

$$^{6}_{3}\mathrm{Li} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{4}_{2}\mathrm{He} + {}^{3}_{1}\mathrm{H}$$

$$^{10}_{5}\mathrm{B} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{7}_{3}\mathrm{Li} + {}^{4}_{2}\mathrm{He}$$

In the first reaction, a neutron (slow neutrons are more effective) enters into the nucleus of the lithium atom of mass 6, and the resulting nucleus, being unstable, breaks up at once into two particles, a helium nucleus of mass 4 and a hydrogen nucleus of mass 3. As there is some residual energy, these particles fly off in opposite directions at high speed. Similarly the second reaction gives two particles, in this case the nuclei of lithium and helium. In order to record the tracks of the resulting particles the disintegration must take place actually in the gelatine, and so the element to be disintegrated must be incorporated into the emulsion. This is quite simply done by previously soaking the plate in a suitable solution and allowing it to dry. For lithium

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lithium sulphate was found suitable, in about 2% solution, while for boron a solution of borax was used. After treatment the plates were exposed for some days to neutrons, and then developed in the usual way. Generally the resulting tracks are in exactly opposite directions, and therefore appear as a single track, and the combined length forms a measure of the total energy of the particles. A knowledge of this enrgy helps us to determine the precise values of the nuclear masses. The lithium disintegration tracks are quite long, equivalent to about 6.6 cm. in air, most of which is the track of the ^3_1H particle. In most cases a short length at one end is quite clearly the track of the ^4_2He nucleus, being much more densely studded with grains. The combined track length for the boron disintegration on the other hand, is only equivalent to 1.1 cm. in air, and it is not usually possible to distinguish the two portions of the track separately. With boron the disintegration is relatively frequent when slow

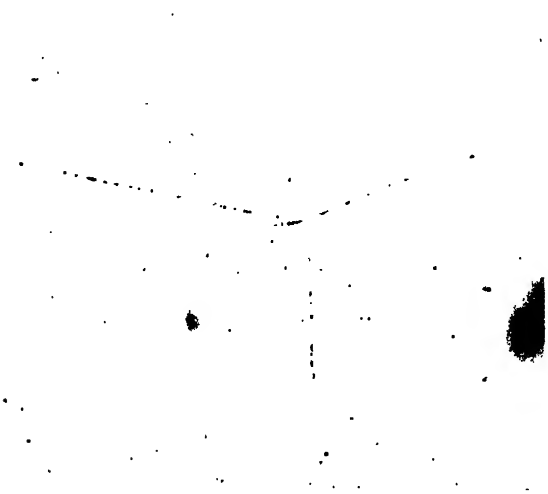

FIG. 2.

Tracks of the α particles emitted during the decay of radiothorium.

utrons are used, and some thousands of tracks ay be found on a square cm. of the plate; whereas th lithium under similar conditions only a few zen are found. Both these reactions have been observed more recently by various workers in Wilson Chamber photographs, and the results deduced from the emulsion tracks have been amply confirmed.

FIG. 3.

The triple disintegration of boron.

Another possible mode of disintegration of boron is the reaction

$$^{10}_5B + ^1_0n \rightarrow ^4_2He + ^4_2He + ^3_1H$$

in which the unstable nucleus disintegrates into three particles, one of which again is the hydrogen isotope of mass 3. An example of this is shown in fig. 2, where three tracks are seen in the form of a "Y". The two short arms of the Y are the tracks of the two He nuclei, and the long arm is that of the ^3_1H nucleus. One short arm does not show very well in the photograph, but is quite unmistakable on the original plate. This interesting reaction takes place very rarely, and has so far not been observed by any other method.

Fig. 3 shows an example of yet another application of the method. The plate in which this star of tracks was found had been soaked in a weak solution of thorium nitrate. The star is due to the disintegration of the thorium isotope, radiothorium. It is well known that when an atom of this element breaks up, in the course of ordinary radioactive disintegration, it emits five α-particles in succession, during the course of a few days. During this time the atom in question is firmly fixed in the gelatine, and so all the five tracks are recorded, radiating from a single point. In this example four tracks are very clearly seen, the fifth is inclined at a steep angle

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and is therefore out of focus in the photograph. The linear magnification in these photographs (figs. 2 and 3) is about 1800 times.

The method also lends itself to the investigation of very weakly radioactive elements, of which samarium has been studied. The samarium is incorporated into the emulsion in the way already described, and the plate is allowed to stand for several months, during which time all the particles emitted are registered. Samarium is found to emit α-particles at the rate of about 80 per gram per second, a very feeble activity by ordinary standards. Radium is five hundred million times more active. It is here that the present method shows to advantage, for it accumulates the effect of all that takes place during a long period, and extremely small activities can be detected. The range of the α particles from samarium is a little more than 1 cm. in air, but it has been shown that samarium also emits particles of longer range, some three or four cm. of air, which are apparently protons. No other element is known to do this, and the proton emission of samarium is so feeble that it is almost beyond the limits of detection by any other method.

Finally, the method of the photographic emulsion is being used by several workers at the present time in the study of cosmic radiation. Here again the property of accumulating tracks over a long period has made it specially valuable. It appears that under bombardment by particles of very high energy, it is possible for a nucleus to emit simultaneously quite a number of heavy ionizing particles, which appear as 'stars' of tracks very similar to the radiothorium stars already described. Such stars have been found by Frl. Blau in plates exposed at a high altitude in the Alps, and again in our plates exposed in Kashmir. From the number and length of the tracks it is possible to make some estimate of the energy involved in these processes. Much still remains to be learnt about these effects, which are only observed in plates exposed at high altitudes.

In very recent years great progress has been made in the technique of nuclear research, and apparatus and methods are now available which only five or six years ago were unknown. It is inevitable that the method of direct registration of tracks in photographic emulsions should fall into the background, except, perhaps, for a few very special purposes. The examples of its application which have been given indicate that it has marked limitations, and the interpretation of the observed effects is sometimes a matter of great difficulty. Nevertheless, in these various ways, it has been, and to some extent still is, distinctly helpful in our investigation of the physics of the nucleus. Perhaps there will still be problems in which this method will be of value. However that may be, during the past few years it has formed a small field of research of very great interest, and students who wish to form some personal acquaintance with α-particles, protons, and the other *dramatis personae* of modern physics, might do worse than study the tracks of ionizing particles in photographic emulsions.

Algebra of the Hindus

History of Hindu Mathematics (A Source Book): Part II (Algebra).—*by Bibhutibhusan Datta, D.Sc., and Avadhesh Narayan Singh D.Sc., Published by Motilal Banarsi Das, Lahore: 1938. Demy. pp. 314. Price Rs. 7/8.*

The present work under review forms part II of the authors' *History of Hindu Mathematics*, and it is devoted to the history of Algebra in India. A perusal of its several chapters will convince the reader of the Hindu achievements in Algebra from the olden times to the medieval, from the period of *Satapatha Brâhmaṇa* (c. 2000 B.C.) up to that of Bhâskara (1150 A.D.), Nârâyaṇa (1350 A.D.) Gangâdhara (1420) and Kṛṣṇa (1580 A.D.), thus embracing a space of time over three milleniums. A review of the first part of this work by the same authors appeared in our columns in its May 1937 issue. In this second part the authors have devoted to as many as twenty-eight chapters, comprehending, *inter alia*, Evolution and Involution, Linear Equations with one and two unknowns, and finally, with several unknowns, the Quadratic Equations, Simultaneous Quadratic Equations, Equations of Higher Degrees, and various types of Indeterminate Equations, etc.

In the general features of Hindu Algebra, the authors have pointed out that the Hindu name for this branch of mathematics is *Bija-gaṇita*, which literally means, "the science of calculation with elements," and the epithet dates as far back as the time of Pṛthudakasvâmi (860 A.D.), while his predecessor Brahmagupta (628 A.D.) called it *Kuṭṭaka-gaṇita*, which means "pulveriser" or, that part of our Algebra which deals with indeterminate equations of the first degree. The origin of the Hindu algebra can be traced back to the times of the *Sulva* (800-500 B.C.) and the *Brāhmaṇa* (c. 2000 B.C.), but the subject was treated in those ancient times in a geometrical manner, *e.g.*, in the construction of altars. There was no recognized terminology for the word "coefficient" in algebra: Pṛthudakasvāmi, the commentator of Brahmagupta, uses for it the term "*anka*" to denote the coefficient of the square of an unknown quantity, while elsewhere, Brahmagupta used the term, "*samkhyá*" and on several other occasions, "*guṇaka*" in the same sense. According to Dr Datta ("The Jaina School of Mathematics," *Bulletin* of the Calcutta Mathematical Society, *21*, 115-145, 1929), the "unknown quantity" was called "*yāvat-tāvat*," meaning "arbitrary quantity while in the Bakhshali treatise, it was called "*yadṛccha*," or "*kāmika*". Āryabhaṭa I (499 A.D.) calls the unknown quantity "*gulikā*" (shot), and from the beginning of the 7th century A. D. the Hindu algebraists have been using the term "*avyakta*" for an unknown quantity. Next comes the "power" of a known or unknown quantity. The origin of oldest Hindu terms for this can be traced as far back as the 4th century B.C. and probably earlier. In the *Uttaradhyāyana-sūtra* (c. 300 B.C.) the second power is called "*varga*" (square), the third power is called "*ghana*" (cube), the fourth power, "*varga-varga*", the sixth power, "*ghana-varga*", the twelfth power, "*ghana-varga-varga*", etc. using a principle of multiplication for higher powers. But no principle for indicating the odd powers, in general, can be found in this oldest work. Brahmagupta coined the term "*gata*" for *any* power, and he added this as a suffix to the name of the number indicating any power, *e.g.*, the fifth power he called "*panca-gata*", the sixth power "*ṣaḍ-gata*" and so on. In the *Anuyogadvāra sutra* (*Brahma-sphuṭa siddhānta*, XVIII 41, 42), a work written before the commencement of the Christian era, terms for higher powers, integral and fractional, successive squares and square roots etc. are mentioned. The terms for "equation" are "*sama karaṇa*" and "*samî-karaṇa*" and simply "*sama*" as originated by Brahmagupta (628 A.D.). Later writers, such as Pṛthudakasvāmi (860 A.D.), Srîpati (1039 A.D.), Nârâyaṇa (1350 A.D.), employed some other terms for "equation". The sides of an equation were called "*pakṣa*", as can be seen in the works of Srîdhara (c. 750 A.D.), Padmanābha and others.

The Hindu name for the "absolute term" in an algebriac equation is "*drsya*" (visible) and sometimes, "*rūpa*" (appearance), signifying the known portion of an equation while the other parts are invisible or unknown. This has been traced in the Bākhshāli Manuscript.

According to the authors there are no special symbols for the fundamental operations, such as addition, subtraction, multiplication and division, in the Bākhshāli work. Usually the procedure of tachygraphic abbreviation is followed. Thus *yu* stands for *yuta* (Sanskrit word: it means "added"), *ksa* (abbreviated from *ksaya*, diminished), for subtraction, *gu* for multiplication (from *guṇa* or *guṇita*), and *bhā* for *bhāga* or division. In later Hindu mathematics, a dot, occasionally a small circle, was placed above a certain quantity to signify subtraction; thus, 7 or $\dot{7}$ means -7. In the *Bijagaṇita* of Bhāskara II (1150 A.D.), p. 2, it is mentioned: "Those (known and unknown numbers) which are negative should be written with a dot (*Vindu*) over them." A similar remark occurs in the algebra of Nārāyaṇa (1350 A.D.).

The modern form of equations and of their solutions is met with under two distinct divisions: first, we may be given an equation (simple or simultaneous) in x, y, z, etc. to solve, as a purely algebraic process; and secondly, a problem which requires to be laid down in an equational form in x, y, z, etc., in accordance with the conditions of the problem. A most familiar example of this latter class is the "digit problem" or "the ages of father and son problem". But in Hindu algebra, an equation was to be written down first, prior to its solution. Thus, the forming of an equation is called "*sami-kriyā*" (*lit.* making equal). Further operation, after an equation has been written down, goes by the name "*nyāsa*" of the equation. The authors have laid down the plan of writing the two sides of an equation, following (*i*) the Bākhshāli treatise, (*ii*) Pṛthudakasvami, (*iii*) Bhāskara, and others, of which the latter's plan is the best, for Professor Smith in his History, II, pp. 425, 426, has observed: "This plan permits of easy transposition".

Regarding classification of equations the authors say that these were made by the earliest Hindus according to the degrees of the equation, *viz.*, simple (*yāvat-tāvat*), quadratic (*varga*), cubic (*ghana*), and bi-quadratic (*varga-varga*). Reference can be had in the *Sthānāṅga sūtra* (*loc. cit*) whose date is *circa* 300 B.C. Later equations were classified by Brahmagupta into five, by Pṛthudakasvāmi into four, by Bhaskara II into four, subdividing equations for elimination into two classes, by Kṛṣṇa (1580 A.D.) into two main classes. Previous to the date of *Sulva* (800 B.C.), as it was already said, the solution of a linear equation in one unknown was purely geometrical. Then solution by the method of the Rule of False Position, which was known to the Arabs and the Europeans in the Middle Ages, had developed when there was no symbol for the unknown. But this method gradually disappeared as can be seen from the later Hindu treatises on algebra beginning with that of Āryabhaṭa I (499 A.D.). But a limited application of this Rule is found in arithmetical treatises, such as those of Srīdhara (750 A.D.), Mahāvira (850 A.D.) and Bhāskara II (1150 A.D.). Rules for solving linear equations of the type

$$ax+c=bx+d$$

involving one unknown, were given by Āryabhaṭa, Brahmagupta, Bhāskara II. Rules for solving linear equations with two unknowns, *viz.*,

$$\left.\begin{array}{l} x+y=a \\ x-y=b \end{array}\right\}$$

were given by Brahmagupta, Sripati, Nārāyaṇa, Gangādhara (1420 A.D.), Bhāskara and Mahāvira. In the *Gaṇita-sāra-saṃgraha* of Mahāvira there are many interesting problems, and more difficult problems occur in the *Bija-Gaṇita* of Bhāskara. A simpler question we may quote, by way of illustration: "One says, 'Give me a hundred, friend, I shall then become twice as rich as you'. The other replies 'If you give me ten, I shall be six times as rich as you.' Tell me what is the amount of their capitals." This means solving the equations

$$\left.\begin{array}{l} x+100=2(y-100) \\ y+10=6(x-10) \end{array}\right\}$$

And Bhāskara has indicated two methods of solving these equations, one by a sort of transformation, and the other by elimination.

ALGEBRA OF THE HINDUS

The earliest Hindu treatment of systems of linear equations involving several unknowns is found in the Bākhshāli treatise. Mahāvira, Nârâyana, Aryabhaṭa, Brahmagupta, Bhāskara II, in their treatises on algebra have discussed methods of solving such types of equations, and Sarada Kanta Ganguli has shown that these methods, on no account, are modifications of the type considered by the Greek Thymaridas and do no fall within the latter's rule *Epanthema* (*vide*, Ganguli, " Notes on Aryabhaṭa ", *Jour. B. & O. Resear. Soc.*, *12*, 88, 1936; and Heath, *Greek Math.*, *1*, p. 94).

The altar-construction of the Vedic Hindus involved the solution of the complete quadratic equation

$$ax^2 + bx = c$$

as well as of the pure quadratic $ax^2 = c$. The geometrical solution is found in the early canonical works of the Jainas (500-800 B.C.) and also in the *Tattvārthādhigama-sūtra* of Umāsvati (c. 150 B.C.), and these solutions were certainly known to the author of the Bākhshāli treatise (c. 200 B.C.). Various problems including one on arithmetical progression reduced to solving a quadratic equation and the details are mentioned in the Bākhshāli work. Āryabhaṭa I (499 A.D.) has tackled interest-problems in arithmetic, amongst others, and these led to solution of quadratic equations. The latter laid down two distinct methods of solution. In one case he multiplied both sides of the canonical equation by $4a$ and other simply by a, in order to make the unknown side of the equation a perfect square. Besides, Brahmagupta gives two specific rules; and these found applications in astronomical problems, and his results are quoted in the *Sūryasiddhānta* (c. 300 B.C.) as also in the work of Srīpati (1039). The work of Srīdhara (c. 750 B.C.) is lost, but the relevant portion on the method of solving the quadratic equation is preserved in quotations by Bhāskara II, Jñanarāja (1503 A.D.) in his *Bijagaṇita*, and Sūryadāsa (1541 A.D.) in his commentary on Bhāskara's algebra. Mahāvira, Āryabhaṭa II, Bhāskara II (1150 A.D.) and Gaṇesa (1545 A.D.) laid down distinct rules for solution. That a quadratic equation has in general two roots were known to the Hindus. Bhāskara II has quoted an ancient writer of the name of Padmanābha, whose algebra is not available now, testifying to this; it was known also to Mahāvira, Brahmagupta, and Pṛthudakasvāmi.

" The Hindus did not achieve much ", say the authors, " in the solution of the cubic and the biquadratic equations ". Bhāskara II (1150 A.D.) attempted the application of the method of *madhyamāharaṇa* (elimination or removal of the middle term) to certain types of equations so as to reduce them by suitable transformations and by introduction of auxiliary quantities to simple and quadratic equations. Hence he thus anticipated one of the modern methods of solving the biquadratic. Mahāvira considered certain simpler equations of higher degrees in connection with geometrical progressions, *i.e.*, equations of the types:

$$(i)\quad ax^n = q$$

$$(ii)\quad a\frac{x^n - 1}{x - 1} = p$$

Āryabhaṭa I, (born 476 A.D.) was the earliest Hindu algebraist to tackle indeterminate equation of the type

$$by = ax \pm c$$

where, in general, a and b are prime to each other and a, b, c are integers. His method was adopted by Bhāskara I (5522 A.D.) and Brahmagupta, and some later writers. From the very beginning the subject played a very important part, and it is noteworthy that a work exclusively devoted to its treatment is *Kuṭṭakāra-siromaṇi* by one Devarāja, a commentator of Āryabhaṭa I. Problems whose solutions led the ancient Hindus to the investigation of the simple indeterminate equation of the first degree were distinguished broadly into three varieties:

$$(1)\quad N = ax + R_1 = by + R_2;$$

$$(2)\quad \frac{ax \pm \gamma}{\beta} = y;$$

$$(3)\quad by \pm ax = \pm c.$$

Various rules and the *rationale* of such rules were given by the elder Āryabhata and the elder Bhāskara but by Narâyaṇa, Jñanarāja, Kamalākara, Brahmagupta, Mahāvira and Śrīpati.

A very interesting problem of the senior Bhāskara runs as follows:

" Tell me at once, O mathematician, that number which leaves unity as remainder when divided by any of the numbers from 2 to 6 but is exactly divisible by 7."

Bhāskara found the number to be 721 by application of his method, where as Sūryadeva Yajvā obtained the number 301 by a different method. This very problem was afterwards treated by Ibn al-Haitam (*c.* 1000 B.C.) and Leonardo Fibonacci of Pisa (*c.* 1202 B.C.) (*Vide* Dickson, History of the *Theory of Numbers*, Vol. II). Mahāvira and Srīpati extended the case to the generalised Conjunct Pulveriser of the type:

$$b_1y_1 = a_1x + c_1,$$
$$b_2y_2 = a_2x + c_2,$$
$$b_3y_3 = a_3x + c_3,$$

But in four palm-leaf manuscript copies of the *Lilavati* of Bhāskara II, Sarada Kanta Ganguli discovered another rule describing an alternative method for the solution of the generalized conjunct pulverizer.

To junior Bhāskara and to Brahmagupta is to be attributed a detailed investigation of the indeterminate quadratic equation of the types —

$$Nx^2 \pm c = y^2;$$
$$ax^2 + bx + c = y^2;$$
$$ax^2 + bx + c = a'y^2 + b'y + c';$$
$$ax^2 + by^2 + c = z^2;$$
$$ax^2 + bxy + cy^2 = z^2;$$

Bhāskara II succeeded in evolving a method called *Chakravāla*, or the Cyclic Method and laid down rules and lemma. Other writers reproduced his methods and incorporated them in their own works. Among these followers may be mentioned Nârâyaṇa, Kamalākara. As a matter of fact Kamalākara's method of solution of the last but one of the above equations was adopted by A. Desboves (1879 A.D.) and Matsunago (*c.* 1735 A.D.) solved a particular case of the same problem.

The earliest Hindu solutions of the equation $x^2 + y^2 = z^2$ are found in the *Sulva*. Baudhāyana (*c.* 800 B. C.), Āpastamba and Kātyāyana (*c.* 500 B.C.) propounded a method for the transformation of a rectangle into a square, which is equivalent to an algebraical identity and thus gave a rational solution of the equation. Later, rational solutions were given by Brahmagupta and Mahāvira. The latter also tackled problems involving areas and sides of a triangle, and rectangles, while the former tackled isosceles triangles with integral sides and with a given altitude and finally rational scalene triangles. The authors are of opinion that Mahāvira's solution of the problem of the rational scalene triangle by the method of juxtaposition of two rational right triangles having a common leg must be given precedence, although it is now current in Europe that the originator of the method is Bachet (1621 A.D.).

An extensive study of rational quadrilaterals was made by Brahmagupta and Mahāvira, including the rational *inscribed* quadrilaterals,rational isosceles trapeziums, pairs of isosceles trapeziums, trapeziums with three equal sides, and inscribed quadrilaterals having a given area. The Hindus do not seem to have paid much attention to the treatment of indeterminate equations higher than the second. But some interesting examples involving such equations are to be found, however, in the works of Mahāvira (850A.D.), Bhāskara II (1150 A.D.) and Nārāyana (1350 A.D.). Bhāskara laid down rules for solving an equation of the type

$$ax^{2n+2} + bx^{2n} = y^2,$$

where *n* is an integer. He also gave solution of the equations

$$x^2 + y^2 = u^3$$
$$x^3 + y^3 = v^2$$

and other equations of degrees higher than the second.

In the *Laghu-Bhāskara* of the senior Bhāskara we meet problems in which three or more Bhāskara we meet problems in which three or more functions, linear or quadratic, of the unknowns have to be made squares and cubes. Brahmagupta and Bhāskara the junior laid down rules for attacking such problems, and sometimes we find a rule by Nârâyana also, stated in very explicit terms. Mention may be made here that the Bakhshali treatise lends a clue to various classes of equations, which we think is indispensable for a research worker in this field of mathematics.

As regards the book, the get up is excellent and the diagrams are nicely drawn. The utmost patience and care taken by the authors and printer deserve credit from the standpoint of Indian printing. The vast erudition and scholarship evinced by the authors would be amply rewarded, we hope, if such a masterly treatise is kept in every college and university library for use of students interested in ancient Hindu culture and that of researchers in the field.

K. B.

Recent Advances in Nuclear Spectroscopy: Some Works in the Kaiser Wilhelm Institute of Physics, Heidelberg, Germany

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IT is a common belief that the progress of scientific researches in Germany has suffered a serious set-back at the present moment. Several eminent Jewish professors and scholars from various German centres of learning have been forced to resign and seek shelter abroad owing to the anti-Jewish policy of the Hitler Government. Some German professors and scholars holding views not agreeable to the National Socialist Government have also met the same fate. One naturally thinks that the standard of scientific researches in Germany has consequently deteriorated to some extent. The present writer had the privilege of working for a couple of years in one of the fore most Research Institutes of Germany. He had thus ample opportunity of looking into the methods of scientific researches in that country and of coming into personal contact with some of the best workers there. The impression carried by him regarding the German attitude towards this question is as follows.

The Germans themselves are conscious that their country is open to the risk of a possible deterioration of its research standard under the present circumstances; they like any other European nation, for a matter of that, like any progressive nation of the world, cannot afford to run this risk; so they are determined to fill up the gap caused by the Jewish evacuation at any cost, and they hope to succeed in doing so at no distant future.

One naturally hesitates to believe that this bright optimism on the part of the Germans is going to be fulfilled in practice. But in coming to any conclusion regarding this question one should also take into account the great difference, in the spirit and outlook, of scientific research in Germany and in our country. Scientific research all over Germany, like her programme of social or political reconstruction, is the outcome of one single organized effort. The Germans believe in careful planning and systematic organization in all matters, specially those which affect the prestige and welfare of the nation. In this the academic workers have not to struggle single-handed, but they receive great encouragement from their Government and close co operation from their innumerable industrial institutions of the country. One great advantage of this method is that the whole system of scientific research functions as one huge machinery, the working of which does not stop at the absence of any individual, however important his part might be. Batches of workers are being systematically trained up at each step of the organization. A second batch is ready quickly to take up the place in the case of a failure of the first. Clever workmanship, high efficiency and fabulous precision in all kinds of technical works – mechanical, electrical or metallurgical, as well as in subjects of pure academic interests are handed down from generation to generation as a proud heritage of the nation. And the aged and the experienced workers look upon this tradition and the responsibility of its maintainance with a feeling almost as sacred as that associated with religion in this country.

This tradition of organized researches seems to be the keynote of the great optimism of the German workers. To give one example of the organized effort in the field of academic researches in Germany, the writer can do no better than present a brief survey of the recent progress in Nuclear Physics made by Prof. Dr W. Bothe and his co workers in the Institut für Physik at the Kaiser Wilhelm Institut für medizinische Forschung,

Heidelberg, about which he has got some personal knowledge.*

Prof. Dr W. Bothe came to Calcutta in 1938 to attend the Silver Jubilee, of the Indian Science Congress, and lectured on some of his works on that occasion. It may also be remarked in passing that he along with H. Becker performed in 1932, the famous experiment of putting beryllium in contact with polonium, and then showing that this gives rise to radiation far more penetrating than gamma rays. They were subsequently identified as neutrons by Chadwick. Bothe and Becker's experiment acted as a trigger to the activities on nuclear research, which marks the present times. The subject with which Prof. Bothe and his co-workers are busy these days is the spectroscopy of the atomic nucleus. The atom, as is now well known, consists of a nucleus which carries a positive electric charge, and a system of (extranuclear) electrons outside the nucleus. The electrons are arranged in definite shells or energy states about the nucleus. A study of the spectrum emitted by atoms furnishes us detailed information regarding the value, position and structure of these energy states. A systematic correlation also exists among the electronic energy states of the different atoms (elements) in the periodic table. Certain facts have likewise pointed out that the nucleus of the atom, although very small in size (radius $\sim 10^{-13}$ cm.), has also got a structure of its own, which in certain respects may be very different from that in the extranuclear part of the atom. Such structure of the nucleus can only be explored with the help of the radiations emitted by the atomic nuclei under certain circumstances. A study of this subject constitutes the nuclear spectroscopy, its object being the determination of positions and energies of the excited levels of the atomic nuclei, the width and interval of the levels, their fine structure, and any correlation among the energy levels of the different known nuclei that might exist. Our knowledge of the structure and behaviour of the extranuclear part of the atom is almost complete; the object of the nuclear spectroscopists is, in one word, to look for the counterpart of that knwledge in the case of the nucleus. The task is, however, a difficult one as will be realized from the discussions which follow. The subject has been developed step by step, to attain its present stage of growth and has been enriched by liberal contributions of Bothe and his school during the last thirty years.

The methods available for investigations in the nuclear spectroscopy depend primarily upon the study of natural and induced radioactivity and, to a great extent, of artificial transmutation of nuclei. The study of radioactivity which historically began much earlier than the other method, showed clearly that the radiations from radioactive bodies consist of α-particles, positive or negative electrons and γ rays. While the α-particles and electrons are charged material particles, the γ-rays are electromagnetic radiations of very short wave-lengths. The α-particles and the electrons gave us the first clue to the kind of the constituent particles of the nucleus. On the other hand a spectrum-analysis of the γ rays showed that they have a line spectrum and that their origin must be connected with the existence of excited levels in the nuclei. The other method of nuclear spectroscopy, namely, the study of artificial disintigration of nuclei led, of all things, to the discovery of other particles, the proton and the neutron, as constituents of the nuclei. Besides, the method gave us the first indication of the enormity of the nuclear forces and the magnitude of the binding-energy of the particles inside the nucleus. In recent years the importance of this method has increased enormously as it has opened to us unexpected avenues of information about the structure of the nuclei. We shall discuss the development of this method in some more details.

Though radioactivity was discovered by Bacquerel in the year 1896, it was nearly twenty-three years later, that the first evidence that a naturally stable atom-nucleus can be broken up by external agencies was obtained by Rutherford (1919) by bombarding nitrogen by means of highly energetic α-particles from RaC'. But experiments of this type were seriously handicapped at that time on account of several factors. First it was early recognised that the nucleus has an extremely small dimension, its radius being of the order of 10^{-13} cm., which is nearly hundred thousand

* About the organisation of the group of Research Institutes known as the Kaiser Wilhelm Institutes, see SCIENCE AND CULTURE, *1*, No. 4, 1935.

times smaller than the radius of the normal hydrogen atom. This makes the probability of 'direct hits' even by very fast particles like the RaC' -α, which might result in actual disruption of the nucleus, extremely rare. Secondly, the energy of the bombarding α-particles might not be sufficiently high for the disruption of the nucleus to take place. This is quite likely, because there exists a strong Coulomb force of repulsion between the α-particle and the positively charged nucleus, hence the penetration of the α particle into the nucleus might not be deep enough to cause disintegration. Thirdly, the technique of detecting the disintegration consisted merely in observing visually the scintillations produced by the ejected particles on some fluorescent screen. As is now well known, all kinds of nuclear particles do not produce equally good scintillations; besides, the method is open to many visual errors, so that many of the outgoing particles might altogether escape detection. At the present time considerable improvement has been made both in the method of producing artificial disintegration of nuclei and in the method of detecting the particles ejected during such transformations. We have got now more efficient projectiles in hand than the natural α-particles from radioactive bodies for bombarding the nuclei. Thus, the neutrons possess no electric charge, they are not repelled by the atomic charges and they can therefore penetrate straight and deep into the nucleus. Besides, the ions of ordinary and heavy hydrogen and of helium accelerated by high potentials are now abundantly used as artificial sources in investigations on nuclear transformations. With the erection of plants for supplying enormously high voltages for accelerating the ions in these artificial sources, (Cyclotrons, high voltage generators) these projectiles can be energised to the extent of about 10 million volts. For example, by using the cyclotron constructed by Professor E. O. Lawrence in California, U. S. A., α-particles of 12 eMV energy can now be produced with an intensity equivalent to that from 5 gms of radium. The methods of observations have also been tremendously improved. We have got now, on the one hand, various types of tube and point-counters working with sensitive amplifying circuits, and on the other hand the cloud chamber, enabling us to make the tracks of disintegration-particles actually visible. Besides, the ionization-chamber in conjunction with the linear amplifier and high frequency-oscillograph has provided the nuclear spectroscopists an efficient means for quantitative studies of nuclear disintegrations.*

In spite of this all-round improvement in the study of nuclear physics, the present situation of the spectroscopy of the atomic nucleus is only similar to that of the ordinary spectroscopy in its early days. We know of a considerable number of spectral lines and energy-levels of the nuclei, but the results are not yet sufficient to decide whether any simple quantitative correlation exists among them. On the other hand, the theory of the atom nuclei at its present stage is hardly in a position to predict such a correlation with certainty. The position of nuclear spectroscopy in this respect appears to be much more difficult than that of the spectroscopy of the electronic shells, the reason for this difference being the complications arising from the existence of a very close interaction between the constituent particles of a nucleus. Bothe and his school, however, face this situation with courage and optimism. Indeed they are of the opinion that this situation in no way interferes with their collection of experimental materials about the nuclear levels as completely as possible.

In the present state of development the experimental methods for the determination of the nuclear levels can principally be divided into two groups which are characterized respectively by (1) "absorption or emission of material particles," and (2) "absorption or emission of light (γ-radiation)." The methods of the first group are in general more rational, as they lead us to direct conclusions about the energy-levels. But the methods of the second group which supply us the differences of the energy-levels are also indispensable as a source of supplementary data. Another important method of recent origin, namely, the photo-distintegration of nuclei

* The principle of the last mentioned method is simple: the disintegration particles are led into suitable ionization chambers; the small current of ionization produced by them are magnified about a million times by means of the linear amplifier, and these magnified impulses of the particles are registered photographically by a suitable high frequency oscillograph.

by hard γ rays, occupies here a special position, about which we shall make some remarks in the conclusion.

According to the theoretical ideas of Bohr, which have been supported by many experimental facts, in any nuclear disintegration one has to deal in general with three different nuclei: an *initial nucleus* which is bombarded; an *intermediate nucleus* which results from the capture of the bombarding particle; and a *final nucleus* which results from the breaking up of the intermediate nucleus. The initial nucleus is always in the ground state, the intermediate nucleus is always more or less excited; the final nucleus can be either in the ground state or in the excited state; in the last case the nucleus emits a γ radiation.

E. Welhelmy has developed in the laboratory at Heidelberg a special method for the determination of the excited states of the intermediate nucleus which has proved very satisfactory in the cases of nuclear transformations caused by fast neutrons. The methods consists in the direct measurement of the total kinetic energy which is set free on the breaking up of the *intermediate nucleus.* To every energy level of the *latter* corresponds a well-defined value of the liberated energy (resonance-energy). But complications may arise due to the formation of the final nucleus in different states of excitation, in which case more than one energy-group belong to one particular energy-level of the intermediate nucleus. For example, this probably could be the case in the transmutation of neon produced by fast neutrons investigated recently by K. Gailer in the laboratory of Bothe.

In our present knowledge of the mechanism of nuclear transformations, the part played by the intermediate nucleus in these processes is very important. On account of an extremely close packing of the particles inside the nucleus the interaction between the nuclear particles is very strong. Therefore when an incident particle penetrates into the nucleus, the energy of the former is quickly distributed among the nuclear particles with great facility. A compound nucleus is thus formed in an excited state, which continues to exist until sufficient energy is concentrated on some one of the particles, which then leaves (evaporates from) the system with the available kinetic energy. The excited compound nucleus can however return to its normal state on emission of one or more γ-ray quanta without giving any particle-disintegration. The probability of such a process against the particle-disintegration is however extremely small, as on account of a very symmetrical nature of the charge-distribution of the nucleus, the emission of dipole-radiation by it is hardly imaginable. In nuclear reactions the intermediate nucleus therefore exists for a time considerably longer than what would be required by the incident particle simply to traverse the nucleus. According to this view, the existence of various states of excitation of the compound nucleus will have, as was first pointed out by Bohr, a characteristic effect on the particle-disintegration. Whenever the energy of the incident particle, together with that of the initial nucleus, approaches the energy of any of the excited levels of the compound nucleus the probability of particle-disintegration in this excited state suddenly increases many times. This results in a corresponding increase in the intensity of the outgoing particle within this range of energy of the incident particle. This is called the *resonance phenomenon* in nuclear disintegrations, and it was first definitely observed by Pose in the proton emission of Al bombarded by α particles. The energies of the incident particle at which sudden maxima in the intensities of the outgoing particle occur, would give us therefore directly the excited states of the compound nucleus. The relation representing the intensity of the outgoing particle as a function of the energy of the incident particle is known as the excitation function of the reaction.

To put this hypothesis of the formation of intermediate nucleus to experimental test, Bothe Wilhelmy and Maurer planned the study of two nuclear transformations the reactions in one of which is the reverse of that in the other, and consequently these reactions take place through the same intermediate nucleus. These reactions are:

$$ {}_5B^{11} + {}_2He^4 \rightarrow ({}_7N^{15}) \rightarrow {}_7N^{14} + {}_0n^1 \quad \ldots \quad (1)$$

$$ {}_7N^{14} + {}_0n^1 \rightarrow ({}_7N^{15}) \rightarrow {}_5B^{11} + {}_2He^4 \quad \ldots \quad (2)$$

In the first case Boron (B^{11}) is bombarded by α-particles and neutron emission is observed. The resonance-levels of the intermediate nucleus (N^{15}) are determined from a study of the excitation-function of the reaction by means of an ionization

chamber in conjunction with linear amplifier and oscillograph. In the second case nitrogen (N^{14}) is bombarded by slow neutrons and the emission of α-particles is observed. The energy-levels of the intermediate nucleus concerned are determined here from a group analysis of the energies of the emitted α-particles as outlined in the works of Gailer. The levels of the intermediate nucleus obtained in the two cases by the two entirely independent methods were found to show striking agreement, as can be seen from some of these results given in the table below:

Energy levels of the N^{15}-nucleus.

Maurer: B^{11} (α, n) N^{14}	Wilhelmy: N^{14} (n, α) B^{11}
1,76 eMV	1,76 eMV
2,53	2,54
3,42	3,27
4,11	4,05

It can also happen that the intermediate nucleus has two different possibilities of transformation. When fluorine is bombarded by α-particles from polonium, both protons and neutrons are emitted. The question then arises, whether both of these processes arise through the same energy state of the intermediate nucleus or not. This question has been investigated by the author in the laboratory of Bothe by determining the characteristic α-energies (resonance-energies) which are favourable for the proton-emission on the one hand and those which are favourable for the neutron emission on the other. The results show that there are certain energy-levels of the intermediate nucleus ($_{11}Na^{23}$) at which both protons as well as neutrons can be emitted: but there are also energy states of the intermediate nucleus at which practically either one or the other type of particle alone is emitted. The same method supplies also grounds on which the assignment of the γ radiations occurring under the conditions of investigations can be based. Savel asserted on certain grounds that these γ-rays arise from a direct excitation of the F^{19}-nucleus by the elastic collision of the α-rays with F^{19} without capture. But the present result shows that the interpretation of these γ rays does not require the assumption of any such third process to be taking place. The final nucleus in the proton-process Ne^{22} and that in the neutron-process (Na^{22}) are formed in the excited states; when these return to their ground-states, the surplus energies are released as γ-radiations.

As regards the final nucleus, it is very often a special problem to ascertain whether a definite experimentally found energy-level is the *ground level* of the nucleus or not: in fact one should take into account the probability that the ground level either may not make its appearance in the phenomenon at all or may do so only very infrequently. If the exact masses of the nuclei taking part in the reaction are known, one can decide this point from the energy-balance of the reaction. Mostly, however, in the reverse way the energy balance is utilized to calculate the masses of the nuclei. A direct solution of this problem can often be arrived at by means of coincidence-measurements. When an intermediate nucleus passes over to an excited final nucleus with the emission of a particle, a γ radiation must appear practically simultaneously with this particle. When no such coincident γ-radiation appears, conclusion can be drawn that the final nucleus which results from the emission of the particular group of particles in question is in the ground state (or in a metastable state). This method could be applied not only to the investigations on induced transmutations as has been done in the case of B^{10} (α, p) C^{13} by H. Maier-Leibnitz and W. Maurer, but also to the investigations on wholly analogous problems in radioactive β disintegrations, as has recently been done by F. Norling to the case of radioactive As^{76} in Bothe's laboratory.

Another possibility for the determination of the ground state of a nucleus is offered by the nuclear photoeffect, that is, the ejection of a particle from the nucleus (generally a neutron) by the action of γ rays. This was first shown by Chadwick and Goldhaber in the case of deuteron. These workers allowed γ-rays from ThC″ to fall on a target of heavy hydrogen and they succeeded in showing that the nucleus of heavy hydrogen (deuteron) splits up into a proton and a neutron under the action of the γ-rays. Knowing the exact masses of deuteron, proton and neutron it follows from these observations that the binding-energy of the deuteron is about 2.3 eMV. The principal component of the

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ThC″-γ-rays possesses an energy of 2.65 eMV. The photodisintegration of deuteron by ThC″-γrays is therefore energetically possible. But applied to heavier nuclei, the ThC″-γ-rays failed to effect the photodissociation (except in the case of Be^9). This is evidently due to the fact that the energy of these γ-rays is considerably smaller than the energy of binding of a neutron in heavy nuclei, which is on the average about 8 eMV (on the neutron-proton basis). W. Bothe and W. Gentner therefore looked for some artificial source of γ rays of high energy which would be able to cause the photodisintegration of heavy nuclei. Although several artificial nuclear transmutations are known which produce considerably harder γ rays, the collision cross-sections of these reactions are so small that the intensity of the γ rays obtained is not sufficient to produce the nuclear photoeffect with observable intensities. Bothe and Gentner, however, tried to detect the photoeffect produced by these γ-rays by means of the *artificial radioactivity of the final nucleus* left after the separation of a neutron. The detection of radioactivity being far easier than the detection of neutrons, they hoped to be able to observe the photo-effect at least in those cases where such radioactive final nuclei are formed. As the following considerations will show, their hopes were very soon more than fulfilled.

The γ-rays used by these investigators were those which originated in a resonance process when Li^7 is bombarded by protons of 440 KeV energy. The energy of these γ-rays is round about 17 eMV which is nearly double the energy required for the photodisintegrations in question. The proton source was similar to that originally designed by Oliphant and Rutherford and later improved by Seemann and Orban. The protons were accelerated by means of the desired high voltage of 440 kV, which was produced by an electrostatic generator working on the principle outlined by van de Graaff. Indeed the erection and successful working of this generator is in itself a technical masterpiece. Recently Bothe and his co-workers have further improved their plant and have been able to produce a voltage of a little over one million volts.

As a result of systematic investigation by this method Bothe and Gentner have succeeded in effecting photodissociation of a large number of nuclei, the ejected particle being a neutron in these cases. Some of their results are shown in the table below. In this Z in the first and the third columns denotes the atomic number of the nuclei photo disintegrated, the second and the fourth columns give the

Z	Radioactive Isotopes.		Z	Radioactive Isotopes	
15	P^{30}	$3{,}0 \pm 0{,}2$ min.	35	Br^{82}	36 hr.
29	Cu^{62}	$10{,}5 \pm 0{,}3$ min.	42	Mo?	17 ± 1 min.
30	Zn^{63}	$38 \pm 1{,}3$ min.	47	Ag^{106}	$24 \pm 1{,}2$ min.
31	Ga^{68}	$60 \pm 2{,}5$ min.		Ag^{108}	2,3 min.
	Ga^{70}	20 min.		Ag^{110}	22 Sec.
	Ga^{72}	23 hr.	49	In^{114}?	$1{,}1 \pm 0{,}2$ min.
35	Br^{78}	$5 \pm 0{,}5$ min.	51	Sb^{120}?	$15 \pm 0{,}8$ min.
	Br^{80}	$16 \pm 0{,}9$ min.	52	Te?	$60 \pm 3{,}5$ min.
	Br^{80}	$4{,}5 \pm 0{,}1$ hr.			

resulting positive or negative β-active nuclei, and the corresponding half value periods with mean errors of measurement are shown against them. The underlined isotopes and the underlined half value-periods have been thus for the first time obtained by these workers; the others not underlined were previously known.

It is noteworthy that there are cases in which no photo-disintegration could be detected with any observable intensity in spite of repeated attempts by these authors. There are, for example, N^{14}, F^{19}, Al^{27}, Si^{28}, Cl^{35}, Cu^{65}, Zn^{64}, Pd^{107} and Pd^{109}. They show clearly that not all the nuclear photoeffects which are energetically possible by these γ-radiations, really have got a sufficiently large probability of occurrence.

An interesting fact revealed by these investigations is that there are elements, of which the same isotope shows radio-activity with more than one half-value period. A notable case is bromine. Natural bromine consists of two isotopes: Br^{79} and Br^{81}. The two corresponding active isotopes obtained on removing a neutron photo-electrically are Br^{78} and Br^{80}. Bothe and Gentner have found that whereas Br^{78} has only one half-value period of $5 \pm 0{,}5$ min., the isotope Br^{80} shows two clearly differing half-value periods $16 \pm 0{,}9$ min. and

4.5 ± 0.1h. The assignment of both these periods to Br^{80} by these authors is also ingenious. From the works of Fermi and his co-workers on the bombardment of Br by slow neutrons it is known that Br gives three activities of half value periods 18 min., 4.2 hrs. and 36 hrs. Now the bombardment with slow neutrons is very likely to result in the capture of the neutron by the nucleus and formation of a higher isotope of the element. Thus the activities observed by Fermi must be due to Br^{80} and Br^{82}. We have then the following activities from Bromine:

Bothe and Gentner (photodisintegration)	$(Br + \gamma)$:	$T_1 = 5$ min.; $T_2 = 16$ min.; $T_3 = 5$ h.
Fermi and his co workers (neutron capture)	$(Br + n)$.	$T_1' = 36$ h.; $T_2' = 18$ min.; $T_3' = 4.2$ h

These show that the periods T_2 and T'_2 are practically the same, so also are the periods T_3 and T'_3. These two periods are produced by either method; hence they must be due to bromine-isotopes of mass number less than 81 and greater than 79, that is, due to Br^{80}. The isotope Br^{80} has therefore activities with two different half-value periods, or it consists of two kinds of Br^{80}, which we call isomers. Such nuclei which have the same charge and the same mass-number, but activities with two different half-value-periods are called *isomeric nuclei*. The other two half-value periods from Br are evidently due to Br^{78} (5 min.) and Br^{82} (36 hr.).

At the present time, after the nuclear photo effect has been successfully produced in a large number of nuclei by means of the extremely hard γ radiations and detected by means of the associated radioactivity, the interest of the nuclear photoeffect has run into still another channel. As already mentioned, it was found that whereas the γ-radiation of 17eMV which arises from the bombardment of Lithium with protons, acts strongly on certain nuclei, in the case of other nuclei the cross section must be considerably smaller in the order of magnitude, as they do not show the effect with any measurable intensity. The effect exhibits, in other words, a characteristic *Selectiveness*. The question then arose whether this selectivity of the effect rests only on the structure of the nuclei or also on the wave-length of the applied γ-radiation. Very recently Bothe and Gentner have succeeded in carrying out the corresponding investigations with a different γ-radiation, namely, that produced by bombarding boron with protons, the principal component of which possesses an energy of 12 eMV. So far as the investigations hitherto carried out show, the ratios of yields for any two nuclei are not very different for the two γ-radiations, and also the absolute yields for the two are of the same order of magnitude. This indicates that the " photoelectric absorption-curves " of the nuclei for γ radiations have a substantially continuous character. It is, however, interesting that a clear alteration in the relative yields appears just in the case of the two isomers Br^{80}: whereas the Li-p-γ radiation produces the two isomers with practically equal activity, the ratio of the 18 min. activity to the 4.5 h activity in the case of B p-γ-radiation is about 2.5.

In order to interpret, this selectivity in nuclear photoeffect on his ' evaporation model ' of nuclear reactions, Prof. Bohr has recently advanced some interesting reasonings. It has been experimentally found that the distance between excited levels of any nucleus diminishes rapidly with increasing energy of its excitation. This suggests that nuclear frequencies can be formed from a linear combination of a few fundamental frequencies. The distribution of nuclear levels will therefore be similar in character to that of the quantum states of a solid body. This suggests a close analogy between the well-known selective absorption of infra-red radiation in solid bodies and the selectivity in the absorption of high frequently γ rays nuclei as observed by Bothe and Gentner. A detailed working out of this analogy, however, awaits further developments both on the experimental and on the theoretical sides.

The above lines, in short, represent a brief survey of some of the important works done in the Physical Institute of Professor Bothe in the Kaiser Wilhelm Institute für Medizinische Forschung in Heidelberg during the year 1937-38. Besides these some other interesting works are also in progress in the Institute, for example, those of Dr R. Fleischmann on the slow neutron-capture and emission of soft γ-radiation by Cd, of Dr H. Maier Leibnitz on cosmic ray showers with cloud-chamber of abnormally long period of expansion and

of Dr K. Schmeisser on the hard component of cosmic rays. But as these works do not directly come under the discussion of nuclear spectroscopy, we do not consider them here.

To the mind of the writer the works described here have, however, an appeal which is of more than mere academic significance. Being present on the spot when these works were under way, he could perceive an invisible under-current of active efforts beneath the surface of this apparent mass of works, which stands to him as a symbol of the life-spirit of the German method of researches,—a manifestitation of the spirit of centralization and distribution, the method of careful planning and organized efforts, the result of honest work and friendliest co-operation. Perhaps he may therefore be permitted to close these lines with one of Professor Bothe's remarks to him in his characteristic semi-serious mood: "Es ist das Geist der Arbeit, das Sie lerner müssen, nicht nur die Arbeit selbst."

Publications Received

Stellar Dynamics, by W. A. Smart (Cambridge University Press).

Cattle Fodder and Human Nutrition, by Artturi I. Virtanen (Cambridge University Press).

Das Mikroskop, by A. Ehringhaus (B. G. Teubner, Leipzig).

Lehrbuch Der Physik, by R. Tomaschek (B. G. Teubner, Leipzig).

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The German Primer for Science Students, by H. G. Biswas (Calcutta University).

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Journal of the Bombay Branch of the Royal Asiatic Society, New Series Vol. 14.

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NOTES AND NEWS

Death of Sir Brajendra Nath Seal

India has lost with the death of Sir Brajendra Nath Seal, which took place on the 3rd of December 1938, one of her most illustrious sons and a renowned scholar and educationist. Born on September 3, 1864, he had his education at the General Assembly's Institution (now Scottish Church College), Calcutta. At the early age of 20, he was appointed a professor in the City College, Calcutta, and after having served as the Principal of Morris College, Nagpur (1887), of the Berhampur College, Bengal (1887-96) and of the Victoria College, Cooch Behar (1896-1913) he was appointed in 1914 the George V Professor of Mental and Moral Science in the Calcutta University, which post he held till 1920 when he was appointed Vice-Chancellor of the Mysore University, a post he held for 10 years with remarkable ability and distinction. He was the author of various publications, the chief of which were (1) *New Essays in Criticism;* (2) *Memoirs on Co-efficients of Numbers;* (3) *Comparative Studies in Vaishnavism and Christianity;* (4) *Race Origins;* (5) *Positive Sciences of the Ancient Hindus.* A collection of his poems written in the later 'nineties was published by the Oxford University Press last year under the title *the Eternal Quest.*

Lahore Meetings

The Indian Science Congress meets this year in Lahore for the third time. Of the interesting subjects the 'Structure of liquids' will be discussed in the Section of mathematics and physics, the 'Role of the modern geographer in India' in the Section of geography and geodesy and 'Psychology in the service of education in India' in the Section of psychology. The agricultural science forms this year a bulky subject inasmuch as four joint discussions will be held on (*i*) 'Erosion and drainage problems in India.' (Sections of agriculture, physics, veterinary research, geography and geodesy, in co-operation with the Indian Society of Soil Science and the National Institute of Sciences of India), on (*ii*) 'Disease and pest resistance in crops' (Sections of agriculture, botany, zoology, in co-operation with the Society of Biological Chemists, India), on (*iii*) 'Composts' (Sections of agriculture, medical and veterinary research in co-operation with the Society of Biological Chemists, India) and on (*iv*) 'The Agricultural Cycle' (Sections of geography and geodesy, agriculture, zoology (*for entomologists*), mathematics and physics (*for meteorologists*) and botany). The discussions on 'A need for uniformity in the physiographic divisions of India'. (Sections of the geography and geodesy, geology, mathematics and physics (*for meteorologists*), botany and zoology, on 'Factors determining changes in religious phenomena' (Sections of psychology and anthoropology) on 'Social disorganisation' (Sections of anthropology and psychology) and on "Scope of private enterprise in archaeological and anthropological research in India." (Section of anthropology) are expected to be of popular interest. Four popular lectures are included in the programme *viz.*, (1) 'Beyond the Stratosphere' by Prof. S. K. Mitra, (2) 'At the Threshold of Industrialization,' by Prof. K. G. Naik, (3) 'Indian Domestic Animals,' by Dr B. Prashad and (4) 'The Pictorial Art of the Punjab,' by N. C. Mehta, Esq., I.C.S. It has been appropriate that a special meeting of the general committee has been convened on the occasion to discuss the problem of 'Science and its social relations.'

In active co-operation with the Indian Science Congress, the second session of the Indian Statistical Conference will also be held in Lahore. Joint meetings will be held with the different sections of the Congress in which there will be discussions on 'Theoretical

statistics' (Section of mathematics and physics), on the "Application of statistical methods in Anthropometry" (Section of anthropology), on "Experimental field trials" (Section of agriculture), on "Application of statistical methods in medicine" (Section of medical and veterinary research). There will be in addition a special section devoted to economic and business statistics.

Besides, the following learned societies will hold their annual meetings during the Congress week at Lahore:

National Institute of Sciences of India, Indian Society of Soil Science, Entomological Society of India, Indian Physical Society, Society of Biological Chemists, Indian Chemical Society, Physiological Society, Indian Botanical Society, Indian Psychological Association and the Indian Section of the Institution of Chemistry of Great Britain and Ireland.

The Wardha Scheme before the Central Advisory Board

The Wardha scheme of education has been for some time, it may be remembered, engaging the attention of the public in general and the educationist in particular. It proposes in short to give a technical bias to education the system of which in this country has been according to many people merely academic and only theoretical. The idea as adumbrated in the Wardha scheme first came from Mahatma Gandhi and was later on considered by Dr Zakir Hussain's Committee set up for the purpose. We devoted some attention to certain aspects of the scheme in our editorial of October, 1938 issue. It formed the main subject of deliberation before the Central Advisory Board of Education which met in New Delhi on December 3 last. It may be recalled in this connexion that the Board appointed in January last year a sub-committee under the chairmanship of the Hon'ble Mr B. G. Kher, Premier of Bombay, to examine the scheme of educational reconstruction incorporated in the Wardha Scheme in the light mainly of the Wood-Abbott report on general and vocational education. The report of the sub committee was submitted to the Board at the last meeting, and it generally approved the recommendations.

The sub committee met in its report the various criticisms levelled against the Wardha Scheme around which gathered many misunderstandings and misconceptions. It observed that the scheme as presented in the Zakir Hussain Report was one of education through activity and not of production as is generally believed, and that this scheme was in full agreement with the recommendations made in the Wood-Abbott Report so far as the principle of learning by doing was concerned.

The sub committee also discussed whether or not it was possible to teach through the basic craft all subjects to the standard anticipated. There was general agreement that in the lowest classes education could be satisfactorily carried out through activities, but certain elements of cultural subjects which could not be correlated with the basic craft must be taught independently. Again, spinning and weaving should not be the only basic craft but any craft of equal or higher educative possibilities could be taught. Stress was laid in the report of the sub-committee on the training of teachers, the raising of their status and pay, etc. While generally approving these recommendations, the Board decided that copies of the Sub Committee's report should be forwarded to provincial Governments for consideration.

The sub committee did not consider the question of financing the Wardha Scheme as this was outside its terms of reference, nor did it make any recommendation as regards the co ordination of this scheme with higher education. To examine these questions of finance and co-ordination and certain other matters arising out of the Wardha Scheme, the Board appointed another sub committee consisting of the following members, with powers to co-opt:—

The Hon'ble Mr. B. G. Kher, Premier and Education Minister, Government of Bombay, Chairman; The Hon'ble Qazi Ataullah Khan, Minister of Education, Government of the N. W. F. Province; Rajkumari Amrit Kaur, Mrs Hansa Mehta, Parliamentary Secretary for Education to the Hon'ble the Prime Minister, Bombay. Dr Zakir Hussain, Principal, Jamia Millia Islamia, Delhi; Pandit Amaranatha Jha, Vice-Chancellor, Allahabad University; Dr W. A. Jenkins, Director of Public Instruction, Bengal; Mr W. H. F. Armstrong, Director of Public Instruction, Punjab; and Mr John Sargent, who has been appointed to succeed Mr J. E. Parkinson, C.I.E., as Educational Commissioner with the Government of India.

NOTES AND NEWS

Among other subjects considered was educational broadcasting in India. Mr A. S. Bokhari of the Broadcasting Department, who was present by invitation, explained the position of educational broadcasting. He stated that at present four All-India radio stations, *viz.*, Delhi, Madras, Bombay and Calcutta, were regularly broadcasting educational programme but that this was purely an experimental measure. It was felt that there should be closer co-operation between the radio authorities and the educational authorities about these programmes. The Board suggested that a strong committee on which the educational authorities should be adequately represented should be appointed for the All India radio station, Delhi, which should be used as a kind of experimental station for educational broadcasting. This would give an opportunity to try various experiments which might be extended to other stations after they had proved successful.

The Minor Planet Hermes

Every student of astronomy is well aware that asteroids are the small planets whose orbits lie between those of Mars and Jupiter. Bode's Law which gives the approximate distance of the planets from the sun (in proportion to that of earth) had to put up with a failure, later on removed with the discovery of the first asteroid on the first night of the nineteenth century by Piazzi of Palermo. Since then quite a large number of these small bodies have been found, so that till the end of 1935 there were no less than 1300 asteroids, known and properly identified, and as many more discovered and lost.

Till 1932 all the interest about these was concentrated on their discovery and identification and there was no peculiarity noticed in the motion of any of the asteriods which behaved exactly as the major planets, and were hence called "minor planets." It was, however, in that year that a new asteroid was discovered whose orbit was found not to lie exclusively within those of Mars and Jupiter but to intersect the orbits of the interior planets. Again in 1936 Adonis was discovered which also crossed the orbits of the interior planets (see SCIENCE AND CULTURE, *3*, 312-16, 1937).

The latest of these eccentric asteroids is Hermes which was discovered on October 28, 1937 by Dr K. Reinmuth. According to its provisional orbit as calculated by Cunningham, the nearest approach to the Earth was at October 30.5, the distance being 485,000 miles. The orbital period of Hermes is 2.1217 years and the eccentricity 0.626.

The Christening of the Heavy Electrons

We published in our issue of November 1937 an article on the heavy electron which is the particle that lives only about a millionth of a second after being born of the cosmic rays. The author of the above article called it *Bose-Electron*, for it, unlike the five fundamental particles, *viz.*, the electron, the proton, the neutron, the positron, and the hypothetical neutrino which obey Fermi-Dirac Statistics, follows the Bose-Einstein Statistics. Since the mass of the Bose Electron, as calculated by Stueckelberg, is 240 times that of an ordinary electron, which is the basic unit of electricity, it is also called the *Heavy Electron*.

Several other names for this are suggested, mainly by American physicists. They are calling it *Barytron*, for "bary" in Greek means "heavy". "*Yukon*" is another name now used chiefly by the Europeans led by Prof. Niels Bohr, the wellknown physicist of Copenhagen, in honour of Yukawa, the Japanese physicist, who postulated its existence before it was discovered by Anderson and Neddermeyer in 1937. This latter name is objected to by some on the grounds that "it is a rather cold name."

We are not yet in a position to state what name the scientists will finally adopt for the heavy electron. "It is a very unstable creature, existing theoretically for a mere millionth of a second when at rest. It is supposed to disintegrate into electrons and neutrinos and neutrinos are particles postulated but not yet discovered." (*Scientific Monthly*).

Mr M. P. Bajpai

We regret to have to announce the death under tragic circumstances of Mr M. P. Bajpai, lecturer in geology in the Department of Ceramics, Benares Hindu University, who met with a fatal accident near Lachhman Jhula in the Almora Dist., United Provinces, on the evening of the 15th November, 1938. He was out in field on behalf of the Government of the United Provinces to whom his services were lent by the University and was carrying out prospecting work

under the newly planned Mineral Survey of the Province.

Mr Bajpai was born in 1907 in the Etawah district, United Provinces, and had his secondary education in the local High School. In 1924 he joined the Benares Hindu University where he studied geology and eventually passed M.Sc. examination in that subject in 1930. After this he took to research and investigated a number of problems many of which were of economic importance and aimed at the development of the mineral industry of the country. He carried out mineral prospecting in several States and many districts of the U. P., C. P., Bihar and Madras Presidency and discovered a large number of new mineral deposits which included mica, felspars, pottery clays, limestones, talc, glass sands etc.

In the brief span of six years as a geologist he published a large number of papers both of scientific and economic importance. His work on Gwalior Trap has been of outstanding value and will remain a work of reference for a long time. Much of his work on the Cuddapahas is yet left unpublished. During the last monsoon he along with a colleague from the department of geology surveyed the flooded districts of the United Provinces and investigated the causes of these floods in this area. He was busy writing report suggesting measures for preventing the occurrence of these floods which are so frequent in our country and devastating in their nature. Although very young, his researches on clays brought him on the Editorial Board of the "Indian Ceramics," a newly started quarterly journal.

International Astronomical Union

The triennial meeting of the International Astronomical Union was held at Stockholm on August 3-10, 1938, and was attended by over four hundred delegates from twenty-eight countries. A meeting like this affords opportunities for informal exchange of ideas, comparison of notes on research problems, and personal contact of astronomical workers from different parts of the world. This year marked a departure from the usual procedure inasmuch as four symposia were held at which papers were read and discussed. The first was on the subject of Emission Lines. Professor H. N. Russell, of Princeton, opened the discussion which was joined by, among others, Dr H. Zanstra (Oxford), Prof. D. H. Menzel (Harvard) and Dr P. W. Merrill (Mount Wilson).

"The second general symposium dealt with the structure of the Universe. Professor Bart J. Bok (Harvard) described how the distribution of stars in the Milky Way could be analysed by counts of stars in different areas of the sky; Dr B. Lindblad (Stockholm) discussed problems of special types of objects in the Milky Way; and Dr Harlow Shapley (Harvard) talked on the irregularity of distribution of external galaxies, part of which is due to obscuring dust in the Milky Way and part to a real non-uniformity in the spatial distribution of such objects.

"Professor A. Unsöld (Germany) and Dr R. O. Redman (England) discussed some astrophysical problems at the third symposium. They were concerned particularly with the chemical composition of stars, and especially of stellar atmospheres.

"At the fourth symposium Dr R. d'E. Atkinson (England) and Dr Benzt Strömgreen (Denmark) dealt with the problem of the source of energy in stars, *i.e.*, with the origin of sunshine. The constant radiation of heat by stars over several thousands of millions of years cannot be explained by the ordinary sources of heat, such as combustion, friction, or compression. Processes by which heavy atoms are built from light ones, with consequent liberation of energy, appear to be a promising and adequate energy source." (*The Telescope*).

Facilities for Studies in the Alienation Office, Poona

The Bombay Government have issued a resolution regarding the facilities to be given for the study of Historical Records in the Alienation Office, Poona It is pointed out that the Marathi and the Persian manuscript Records preserved in the Peshwa's Daftar, Poona. have been fully explored and partly published. Their nature and range is now known and nothing which is likely to raise vexatious land disputes has been found among them. At the same time, there appears to be a feeling among the public that adequate facilities are not given to students of history wishing to do research work among these materials. As an improvement in this direction can be made by following the lines of work in other public Record Offices, Government after consulting Sir Jadunath Sarkar and Rao Bahadur G. S. Sardesai, who have edited the Poona Presidency Correspondence and the Peshwa's Marathi Records and

also possess wide experience of record management from their long membership of the Indian Historical Records Commission, have issued instructions to the following effect. The old Modi, Gujarati, Kanarese and Persian Records of the Alienation Office which are mainly of a historical character as indicated in the Hand Book to the Records in the Alienation Office, Poona, sanctioned by Government in 1933 should be freely offered for inspection by research students on formal application as required by the Rules for Inspection contained in the Hand Book to the Records mentioned above. Certain other Records should be made available for study in the room of the Alienation Office in which the editorial work of the Peshwa's Daftar Series was done, and should be at disposal of the newly appointed Archivist for his own study and for study by authorised investigators.

Any notes made or copies transcribed by an authorised investigator shall *not* be taken out of the Alienation Office unless the Assistant Commissioner has first passed them. The censoring by the Assistant Commissioner shall be done with the least possible delay. The notes and transcripts made by authorised investigators shall be accepted by the Assistant Commissioner for censoring, even if hand written, provided they are clear and legible. Translation into English shall not be insisted upon. There will be no objection to the histories of old official or noble families being studied or copied. The new arrangements should be given a trial for one year, in the first instance, and the public should be warned that if the concessions are abused and any damage or loss is caused to the Records these orders will be cancelled and access to the Records by research students will be restricted.

Transfer of "The Scientific Monthly"

The Scientific Monthly which has been an official organ of the American Association for the Advancement of Science since 1907 has now, we learn, been transferred to the Association following an offer by it at its annual meeting held in Atlantic City in December 1936 to the extent that it may be received by all its members. Now the *Monthly* is to be edited at the Washington office of the Association. We quote the following lines from the journal in its November 1938 issue written in this connexion.

"The transfer of the journal to the American Association, combined with efficient editorship, should give the country a better journal of general science than it has ever before had. It should greatly increase the membership of the Association and have the co-operation of all workers in science. There will be no change in editorial policy, but an endeavour will be made to make the journal not only authoritative, as it has always been, but of greater interest to those educated people who wish to follow the advances and share the spirit of science, the dominant factors in modern civilization."

It may be mentioned here that the *Scientific Monthly* was established under the name *The Popular Science Monthly* by J. W. Youmans and the firm of D. Appleton and Co. in 1872. The journal attained much influence and a relatively large circulation, and can boast of having published contributions by such eminent scientists as Darwin, Spencer, Huxley, Tyndall, and so on. The journal, however, due to various reasons became unprofitable, "having been conducted for a time at an annual loss of about $10,000, when it was sold to the present owner and editor Dr J. McKeen Cattell."

Dibar Dighi brought under Protection

Divyoka is remembered as the hero of the revolution in Bengal, in the last quarter of the eleventh century A.D. He was elected king after the fall of Mahipala II, the reigning king of the Pala dynasty of Bengal. The Dibar Dighi which is situated in the very heart of the Varendra area of North Bengal, at the village of Sapahar, in Dinajpur District of Bengal, and the 32 feet high granite monolith pillar standing in the centre of the Dighi, have been suggested of late to be monuments of Divyoka. The pillar itself which is octagonal in shape, capped by an elaborate capital, is called the Dibar Pillar to which the Dighi owes all its archaeological importance. We are glad to learn that the Government of India have recently issued orders extending, under the Ancient Monuments Preservation Act, protection to the famous tank (the Dighi) and a space of ten feet around the embankment.

SCIENCE IN INDUSTRY

Developments in Radio Receivers

Very novel and interesting radio sets designed to remove both human and mechanical obstacles to better reception of broadcast programmes on medium waves are the features of the 1939 models now put in the American market.

The 'time tuning' device fitted to some of the 1939 G. E. sets eliminates the human side. This device makes it possible to preselect any one of the five stations for any fifteen minute period over a full twentyfour hour span. It is only necessary to select the items from the published programmes and set the timing switch. It is then not necessary to go near the set, which will turn on and off, change stations, and perform manual functions automatically.

The full technical details of this device are, however, not yet available.

Another interesting feature of some of the G. E. sets, is the use of a 'beamascope,' a built-in shielded loop antenna that eliminates the nuisance of outside antenna and ground connections, and reduces local noise interference. This device is of great engineering interest. The electrostatic shield used consists of a weave of wires and fabrics. The wires running up and down are insulated from each other by the fabric weave except at the top end where all the wires are soldered to the top plate. The bottom contains shield plate exactly like that used at the top except that only one wire connects to the bottom shield. The loop is mounted inside this electrostatic screen.

Where local interference noise is encountered, the reception is improved by rotating the beamascope so as to balance out the electromagnetic field of the noise sources. The electrostatic field of the noise being eliminated due to the shielding. The intensity of the received programmes is entirely unaffected, since the reception by the loop is due to the electromagnetic components of the signals. Most noise signals originate near the receiver, and the interference, after the beamascope is properly oriented, is mostly due to the electrostatic component which is stronger than the electromagnetic component. The shielding is thus important in reducing the noise.

Artificial Plastics

The *New York Times* reports that four research workers in the Department of Agriculture in the U. S. A. have developed a method for converting saw-dust, straw, wood waste and waste sugarcane stalks into valuable synthetic plastics. We reproduce the following from it:

"The inventors have found that by cooking any one of these waste materials with water and aniline under steam pressure a material is obtained which can be moulded to form a hard, dense, black, shiny product like glass. It has high strength and resistance to water and moisture. It is an excellent electrical insulator. Buttons, door knobs and steering wheels for autos, radio panels, etc., may be made from the plastic.

The process is simple, requiring but three hours for cooking. The yield is from 85 to 95 percent of the original waste material. After the compound is dried it is ground into powder. Under heat and from 1,500 to 3,500 pounds of pressure, the powder is moulded into the synthetic resin.

The patent, taken of the new process, is assigned to Henry A. Wallace, Secretary of Agriculture. The inventors thus give the government the right to use their invention without any payment of royalties."

It is interesting to note that recently the University of Calcutta jointly with Dr M. N. Goswami, now officiating Head of the Department of Applied Chemistry

has taken out a patent for the manufacture of plastics from some of the seed-oils of India.

Synthetic Silk

A new artificial silk, superior to natural silk or any synthetic rayon in its fineness, strength and elasticity has been patented by the late W. H. Carothers, chemist of the E. I. du Pont de Nemours Company.

Completely synthetic in their origin, the new fibres can be easily drawn to a size equal to the diameter of a natural silk filament, or in the extreme case, to only one-seventh of the diameter. Yet the new fibre shows a tensile strength equal to or better than that of silk. In some cases the fibres are 50 per cent stronger than silk.

"The elastic recovery of these fibres under moderate elongations was very remarkable," states the patent, "and in this respect was much superior to existing artificial silks."

This excellent recovery of the fiber, after stretching, makes it "especially useful in the preparation of knitted wear, such as stockings, gloves, sweaters, underwear suits, etc."

The fibres are "lustrous and silky in appearance" and are almost completely insensitive to moisture. When made into fabrics the synthetic fibre fabric possesses a far better elastic recovery than natural silk.

The Carothers patent (No. 2,130,948) with 556 broad and basic claims describes the production of fibres from long chain amine compounds. These are prepared by reacting diamines and dibasic acids. Out of this reaction come acid salts which are crystalline solids having fairly definite melting points. Eight specific ways of creating the new fibres are described. A typical reaction is a mixture of 14.8 parts of pentamethylene-amine, 29.3 parts of sebacic acid and 44 parts of mixed xylenols.

A remarkable property of the new fibres is the ability to stretch them up to 700 per cent and thus create permanently an almost complete alignment of the material. Under X-ray study sharp diffraction images are obtained which denote a "true fiber".

While extremely fine fibres can easily be drawn by the new process, it is also adopted for the production of longer filaments which are useful as bristles, artificial straw, fishline leaders, musical instrument strings, dental floss, horse hair and mohair substitutes and the like. The bristle filaments have "good snap, toughness and resistance to water". The du Pont Company has already announced a brush containing synthetic bristles which, it may be suspected, contains the new fibres.

While the fibres have a lustre like silk, it is easily possible to treat them and reduce or destroy the lustre, states the patent. Textile experts of the National Bureau of Standards believe that it will be some time before the new fibre will be on the market in most important application, the hosiery field. (*Science Digest.*)

Manufacture of Motor Vehicles in India

The use of a motor car by one out of every five Americans, *i.e.*, practically by every family has become a matter of very common necessity in America for quick transport. The factors responsible for this are primarily low production costs due to wide use of machinery and mass production methods in manufacture and to cheap gasoline as also the splendid network of first class motor roads. The cost of buying a car is thus managed within easy means and since the cars in America are generally self-driven and there is cheap motor fuel, the maintenance of a car does not tax the pocket of a man of average means. The number of persons per motor vehicle in other countries, even in Germany, which has no oilfields, scarcely exceeds 100. But in India it is more than 1400 (this figure is for the year 1934). The reason may be traced to the fact that the cost of an imported car in India prohibits one with average means to own this necessity. But still with

the passage of years the use of motor vehicles, both cars and trucks, is becoming more common. In the year 1932-33 she imported 6,701 cars and 8,877 trucks which figures for 1934-35 are respectively 14,348 and 24,187. These figures are sure to be increased more if a serious attempt is made to popularise motor transport by adequate propaganda as is done in other countries particularly in America. Here in India it is expected that persons with a monthly income of Rs. 300 may be induced to own a car, if the cost, *i.e.*, the capital expenditure is halved. It may be argued that consumption of vehicles will soon reach the maximum point and thereafter no new vehicles will find any market. But a look at the new models and fashions will convince one how millions of cars are being consumed annually in countries of origin. The U. S. A. produced in 1934, 2,753,111 cars of which only 236,313, *i.e.*, 8.6%, were exported. It should be noted here that Canada, being within the British Empire and enjoying imperial preference, has been selected by some manufacturers as the exporting country in view of tariff regulations and she also exported only 37.1% of her total production which was the largest export figure in 1934.

The immediate concern of an Indian automobile manufacturing company should be to produce a serviceable car, comparatively cheap to purchase and economical to maintain, and capable of good mechanical performance. From year to year thereafter, research should be carried on and changes made to adapt the car to Indian conditions, such as climate, fashion and economy of operation whenever such changes are likely to stimulate sales.

It has been seen from a survey of the types of cars registered in India that the Ford and the Chevrolet models contribute 20 and 15 per cent respectively. Next comes the low power car, *viz.*, Austin 7, 10 or 12 and Hillman Minx and Baby Ford. It will be therefore prudent to proceed along the line of least resistance and manufacture first

(1) *A medium power Passenger Car like the Ford V.8, the Chevrolet, or the Plymouth; and*

(2) *A Commercial Truck of 1½ ton capacity.*

The same engine will be used for both the vehicles, namely, a 6-cylinder engine of about 24 to 28 H. P. with suitable alterations in frame, rear axle, transmission, etc.

It is an advantage for us in India that materials can be had at cheap rates and that we can have also cheap labour. There cannot be therefore any serious doubt about the prospects of the industry of manufacturing motor cars in this country. It is proposed to give here fuller details about the automobile industry, reference to which was made in these pages.*

The industry, as has been found from the experience of the factories abroad, needs to be built in stages, *viz.*,

(1) Putting up and working an Assembly Plant in the first year, chiefly with imported parts and accessories.

(2) Manufacturing some parts locally and assembling about 6,000 cars and trucks in the second year.

(3) Completion of and working a full sized factory in the third year the number of cars and trucks depending on the market demand, probably 12,000 vehicles in all; and

(4) From the fourth year onwards, to go on manufacturing as many as can be sold up to a maximum of 15,000 vehicles.

Figures supplied and supported by experts in this line on the above broad heads of the industry pertaining to the capital costs for the same are given below:

	Rs. lakhs.
FIRST STAGE.—Assembly Plant only.	
Assembly Plant capable of assembling 10,000 cars and 5,000 trucks ..	18.00
Building for same including land ..	7.00
SECOND STAGE.—Manufacturing plant.	
(Additions necessary for a factory of the full capacity proposed).	
Plant and Machinery for the manufacture of motor engine, clutch and transmission	24.00
Do. for manufacturing Body ..	20.00
Do. for manufacturing Rear and Front Axles ..	10.40
Additional Floor space for Machinery and Tools	2.70
Working Capital	50.00
TOTAL ..	132.10

Or, say, in round figures Rs. 130 lakhs.

* SCIENCE AND CULTURE, *4*, 255, 1938.

Though a few foreign assembly plants are in operation in India, the first stage is necessary to train the staff and the labour. It will also help to dispel any misgivings for the personnel of the future manufacturing plant. It will moreover provide an opportunity for spade-work in favour of sales of the indigenous productions. In the second stage, while manufacturing parts, the wise policy should be to make easy parts first for which the following order should be observed:

(1) Body, (2) Rear and front axles, (3) Transmission system, (4) Engine.

The automobile industry is a complex business. It is to be conducted on a big scale and at the same time it requires much skill and scientific accuracy in the productions. It is only capable of earning profit when productions exceed at least 5,000 vehicles a year. In Europe and the United States of America, which can claim a long history behind this industry, the individual parts and accessories which go to make up an automobile, are still manufactured in numerous small factories or workshops. There the persons concentrate attention on one or a few parts only and by adopting intensified division of labour and mass production methods they have gradually come to acquire specialised knowledge and high technical skill. Maximum number of parts made in a central factory amount to 80 per cent of the total, some make only 30 to 40 per cent.

Below is given an estimated cost of finished car parts ready to assemble.

Parts.	Cost in Rupees.	Percentage of Total cost of Car.
I. *To be Manufactured in Central Factory.*		
1. Body ..	499.50	35.22
2. Axles-Rear and Front ..	94.50	6.66
3. Clutch ..	9.31	0.66
4. Transmission Gear Box ..	66.20	4.67
5. Engine ..	256.36	18.08
6. Steering Gear ..	14.14	1.00
7. Brakes-Hard and Foot ..	38.90	2.74
	978.91	69.03
II. *To be made in the Central Factory or by Subsidiaries or to be Imported as conditions permit.*		
8. Chassis Frame, Mudguards, Hood, etc., ..	102.60	7.23
9. Wheel and Tyres	114.10	8.04
10. Petrol Equipment	14.25	1.00
11. Electrical Parts ..	72.30	5.10
12. Radiator ..	35.61	2.51
13. Instruments and Tools .	19.44	1.37
14. Springs ..	34.42	2.43
15. Bumpers ..	10.88	0.77
16. Propeller Shaft .	10.85	0.77
17. Exhaust Pipe and Muffler .	4.88	0.34
18. Lubricants ..	3.80	0.27
19. Paints ..	16.17	1.14
	439.27	30.97
TOTAL Rs.	1,418.18	100.00

Of the above, the manufacture of wheels and tyres, radiators, chassis frames, electrical equipments, instrument panels and carburettors have been specialised by certain firms abroad on a mass production scale. It will be economical to import them for some time at least. Some of these parts, of course, like speedometer, if they are attempted in a single all-inclusive factory, are likely to be crude and costly. But with the growth of the industry in India many plants will surely spring up aiming at the production of these parts because there will be a ready market. The following list may give an idea of the varieties of parts of a motor vehicle that can be manufactured by individual firms;

(1) Motors, (2) Transmission, (3) Steering Gear, (4) Frames, (5) Axles Rear and Front, (6) Fenders and Guards Hood, (7) Lights Head, Tail, Side and Inside, (8) Batteries, (9) Starters, (10) Running Board, (11) Gas Tank, (12) Radiator, (13) Glass Windows and Frames, (14) Body, (15) Wheels, Tyres, and Brakes, (16) Cushions Upholstering, (17) Horns, (18) Spark Plugs, (19) Spring-Front and

Rear, Valves, Cushions, Bumpers, (20) Shock Absorbers, (21) Gaskets, (22) Tubing, Bolts, Nuts, Brass Castings, (23) Tools and Machinery.

The above is an exhaustive list of industries enjoying subsidiaries in Detroit, which is the chief centre of the automobile industry in the United States of America with an aggregate capital of Rs. 550 crores. Many car makers in America are known to obtain even the parts in castings, forgings etc., in a crude form from foundries and forge shops and these are heat treated, machined, assembled and given a finishing touch in the Central Factory.

In India, however, it will be necessary and advisable to manufacture alloy steels, cast iron and non-ferrous parts of different specifications on a small scale. The equipment for castings and forgings consist of a cupola, an electric furnace, a hydraulic press, a few forging hammers and a 16 inch 3-high rolling mill. The cost for these should not exceed Rs. 12 lakhs. In this connection only body sheet will have to be brought from outside. The body of the car may be all steel or of the composite type consisting of both steel and wood. All steel body is good for Indian conditions but besides the cost of steel, that of presses and dies will amount heavily for an estimate of 12,000 to 15,000 vehicles. And on the other hand, since the total annual imports into India have averaged only about 19,000 during the six years ended in 1935, it would not be prudent to risk capital in equipment, and attempt to produce more than 12,000 cars to begin with.

As will be evident from the foregoing, no exaggerated claims on the prospects of the industry have been made and the situation in India has been fully appreciated. The manufacturing processes have become so mechanised that it is reported only 5 per cent of the labour in Ford factory is skilled. It will be necessary in the beginning of the industry in India to import a number of experts and engineers but there seems to be no difficulty in getting the services, with regard to this, from foreign firms including the training of a few Indians in their factories. This will be expedited when one or two automobile factories will be taken into confidence by the promoters of the industry here. They will be asked to estimate costs and to make a complete detailed scheme and to have it executed under their guidance. It will be interesting to point out that some of the American automobile companies have established branches in foreign countries. They have financial interests in the branch firms but the labour and controlling staff employed are entirely, or almost entirely, from the country in which the branch factory is situated. The examples are Dagenham Ford and Vauxhall Works in England, Opel and Ford in Germany and Matford in France. The Ford Company has been helping the Russian Government to build up their motor plants. The interest of Mr Ford in this transaction has been that the Government there have agreed to purchase from him machinery, equipment and tools valued at over rupees ten crores spread over five years.

In the United States of America some of the smaller manufacturing firms are being pushed out of business by the larger ones geared to mass production. They are likely to consent to transfer their plant and services to India. But as co-operation with small firms has disadvantages inherent in them, it should be sought only if the larger firms fail to respond.

The basic need of this industry as was mentioned earlier in these pages is the co-operation of the political and money power of the country. The question of capital can be answered very efficiently if the Government can be induced to contribute, say, 25 per cent of the capital, which is Rs. 150 lakhs at a modest estimate, in view of the importance of this industry for the army, the railways and other Government departments and also in view of the nation-building value of the industry. The remaining portion of the capital may be raised by shares to be collected from all parts of India. For efficient working of the industry, besides a board of directors, there shall be a executive committee to conduct the business part of the undertaking consisting of 4 members of the board of Directors, and 3 executive heads of the factory. On these conditions the public will be easily induced to subscribe to the capital of the company.

As regards co-operation of political power, in the initial stages help would be required from the Government of India in the following directions:

(1) The existing duty on motor vehicles is now a revenue duty liable to be altered with each Revenue Budget. At present it is 30 per cent against product of the United Kingdom and other countries within the British Empire, and 37½ per cent against non-Empire countries. In the case of India a tariff duty of at least

50 per cent should come into force from the date the new factory is able to produce 6,000 vehicles.

There should be a clear understanding that the duty would not be less than 37½ per cent for at least 10 years from the date the Company begins to market its vehicles, and, if for any reason it is lowered, the industry should receive adequate money compensation for loss of that advantage.

(2) Government should agree to purchase from the new factory the supply of motor cars and lorries ordinary required for the army, the railways and other Government departments and services. They should supply a reasonable list of requirements in advance.

(3) Refund of duty should be allowed on foreign raw materials and semi finished parts imported for assembly plants started within the country.

(4) Concessions should be available for the first five years in regard to railway freight for raw materials and finished cars in connection with the industry.

These are not unjust or unpractical propositions. In Germany since 1933 Herr Hitler has been offering concession or a percentage reduction on income tax to those who are purchasing a motor vehicle of German make. The result has been that Germany, which produced 41,000 cars in 1932, manufactured 180,000 cars in 1935. The foreign cars have to pay a heavy import duty and also a tax, which is not payable in the case of German cars. Every government department, every local authority, city municipal corporation, hospital, is obliged to buy German cars. Today Germany ranks third in the list of manufacturers of motor vehicles of the world, America and Great Britain occupying the first two places.

Besides the economic possibilities of the motor car manufacturing industry, it is sure to communicate a psychological advantage to many kindred industries and this advantage will be reflected in increased employment and extended buying power. Further, the industry will not be only a source of more employment for our people but will also mark a definite step in our defence programme. It is an industry which is capable of expansion in other directions and has nowadays been transformed to a different character for catering to war materials as is evident from the records of the 'Morris' in England, 'Skoda' in Czechoslovakia, etc.*

* Based on *Proposals for an automobile factory Bombay* by Sir M. Visvesvaraya.

MEDICINE AND PUBLIC HEALTH

Treatment of Pulmonary Asthma with Vitamin C

Hagiesco and his associates think that the unreliability of the results obtained heretofore in the treatment of pulmonary asthma justifies trials with new measures. Numerous investigation on vitamin C disclosed a number of pharmacodynamic action which warrant its employment in disorders that have nothing in common with C avitaminis or C hypovitaminosis. For instance, it has been proved that vitamin C is a powerful catalyzer, that it stimulates the activity of different ferments that it contributes to the maintenance of the functional activity of the bone marrow and of the capillaries, that it possesses antitoxic and anti infections properties, that it influences the sympathetic nervous system, that it has a direct effect, that it influences the tonus of the heart and that it has a strong antianaphylactic action. Relative to the latter property the authors point out in *Presse Medicale*, Paris, *46*, Sept. 24, 1938 that in various pathologic disorders which are due to alergy it has been demonstrated that ascorbic acid diminishes the hyperergic manifestation as well as the modifications in the equilibrium of the blood proteins which are characteristics for these hyperergic conditions. They cite reports from the literature on the antianaphylactic action of vitamin C and on its use in the treatment of asthma and then state that they used vitamin C in twenty cases of asthma most of which were obstinate. In fifteen of these cases the results were good or favourable, while in the other five cases they were doubtful or negative. The authors give several case histories and then analyze the results. They take up separately the action on the individual attack, on a series of attacks and during a period of intermission. Regarding the action on the individual attack, they say that the injection of vitamin C has suspensive action but that the return to a normal respiration is slow (from fifteen to thirty minutes) and even then may be incomplete. The intravenous injection is the only really effective mode of administration during the attack and the doses must be comparatively high. At the first injection from 200 to 300 mg. should be administered. if no improvement is observable after fifteen minutes another dose from 100 to 200 mg. may be given. About the effect of vitamin C on a series of attacks, the authors say that in the cases which react well to the vitamin C therapy the attacks cease entirely after from one to five injections and that the attacks always become less severe and prolonged. During the period of cessation the injections are continued intermittently. Patients with certain prodromal symptoms should have an injection every time that it seems necessary. It is advisable to give other patients at least five or six injections every month of 100 mg. each. The mode of administration is intravenous. The intramuscular injections are reserved for the periods of intermission and for the cases in which intravenous injection is impossible. The authors found that the oral administration of vitamin C has no anti asthamtic effect.

The State and Medical Research

Sir Edward Mellanby, secretary of the Medical Research Council, London, delivered the Harveian oration at the Royal College of Physicians on "The State and Medical Research". He said that private endowment of research had no proud history in Great Britain although there had been fine exceptions in the case of medicine. As to government support, it took a great war to make the government set up the Department of Scientific and Industrial Research in 1915. The Medical Research Committee was originated in 1913 in connection with the National Health Insurance Act. This arrangement was terminated in 1919, and the Medical Research Council received its present title and constitution in 1920. It is financed with money provided by the government. During the present century there

have been two rapid increases in medical research activity, running side by side: the one in his country, organized and to a large extent financed by the State, the other in the United States, richly endowed and controlled by private interests. Each had already produced a good harvest. The recent Nuffield scheme, started at Oxford, was possibly an indication that private persons would in the future regard the endowment of research here as more worthy of their support. The most limiting factor in all research activity, and especially in medical research, was personnel. The number of people who were trained for and capable of doing work of this type was not large. By various means the council was trying to increase their number.

Speaking of the work of the National Institute for Medical Research, Mellanby said that it had always reached the highest standard. One aspect of it, of particular interest to the physician, was the biologic standardization of drugs. In this the institute led the world and had rendered a great service to mankind. Another line of policy was the placing of units of research in different institutions, and this has shown great developments in recent years. Short of a catastrophic change, which might upset or even destroy national life, the future was bright. There was no doubt that more and more knowledge, giving control, both preventive and curative, of disease would be obtained. The difficulty he foresaw was not that of obtaining knowledge but of its application to human needs. This would depend on the education and wisdom of individuals. Without an enlightened public opinion the average person would do nothing to save himself, and the State would do less.

Treatment of Hemophilia with Female Sex Hormone

Kocsis and Hasskó point out in *Deutsche Medizinische Wochenschrift*, Leipzig, *64*, that since women do not show the symptoms of hemophilia although they transmit it to their offspring, it has been concluded that the sex apparatus and the endocrine system of women prevent the manifestation of the disease. Consequently attempts were made to counteract hemophilia by means of female sex hormones. They describe case histories and then take up the dosage, pointing out that during a hemophilic hemorrhage, from 500 to 1,000 mouse units of female sex hormones must be administered daily. They maintain that the best results are obtained by the intravenous injection of a preparation that contains all the hormones of the ovaries, but that the subcutaneous injection into the extensor surface of the thigh is the more simple method. During severe hemorrhages, 500 mouse units may be administered by intramuscular injection twice daily and the action of this treatment can be supported by corpus luteum tablets. The capacity of the ovarian hormone to arrest hemorrhage and promote coagulation was proved also when it was administered locally, for instance in tooth extractions. In vitro tests corroborated the coagulating effect of ovarian hormone extract on hemophilic blood.

Tests for Renal Function

Biancardi states that chromoscopy by indigo carmine is a more sensitive test than descending pyelography for the measurment of renal function. The author carried on a comparative study of the elimination, in the same patient, of indigo carmine and opaque substance which was intravenously administered for descending pyelography. The observations were made in a group of 150 cases which included pyelonephritis, renal ptosis, hydronephrosis from either renal ptosis or ureteral or pelvic calculi, calculous and other forms of pyonephrosis and hydropyonephrosis, renal tuberculosis, renal tumors, hematuria, renal ectopia, contusion, cystitis and some other renal diseases. He found that grave alteration of the renal parenchyma are shown by disturbances of the same intensity in the elimination of the indigo carmine and of the opaque substance. When the parenchyma is slightly involved the elimination of the pyelographic substance is normal, whereas indigo carmine is either insufficiently eliminated or not eliminated at all.

Minerva Medica, Turin, 2, Sept. 15, 1938 through J.A.M.A., *111*, Nov. 12, 1938.

Public Health in India

Few of you have probably ever dreamt of comparing a health report, in official blue book covers, with a "crime novel", but that is what I am going to do. The average detective story, as a matter of fac , is not nearly so exciting as those to be found in the health reports of this country. We epidemiologists are constantly engaged in following up clues, leading to detection of the agents causing sickness and death, and of the methods these agents adopt; in some cases they may be virulent germs, like those of cholera or plague, in others, murderous female insects like the stegomyia or the anopheles, able to spread yellow fever and malaria. Each has its own special plan of attack.

Every health officer can have all the thrills he wants in work of this kind. The prevention of murder is seldom dealt with in fiction, in the field of epidemiology, however, whilst the expert, unfortunately, has many murders to investigate, his main purpose is the prevention of these crimes against humanity. There comes the thrill, and the epidemiological sections of the Public Health Commissioner's report contain the exciting stories.

Another chapter describes the numerous enquiries being conducted by research workers. The more important subjects under investigation include malaria, mal nutrition, cholera, plague, leprosy, tuberculosis, maternal and child mortality, rabies and kala azar, but there are many others. In each of these directions, highly skilled detective work is constantly going on, the Government of India, through the Indian Research Fund Association, providing annual grants, in order that by these means sickness, suffering and death may be reduced and prevented. Both central and provincial government laboratories are engaged in similar work; for instance, millions of doses of different preventive vaccines are manufactured every year, whilst during 1936, no less than 25 million persons were vaccinated or re vaccinated against small-pox alone. I can assure you that every anna of the money allotted is well spent, and handsome annual dividends are earned, both in the saving of thousands of lives and in the form of new knowledge, the practical application of which makes for the betterment of public health. You will appreciate the satisfaction to be derived from having a share in such work.

Before passing to other subjects, I would remind you that the Public Health Commissioner's report attempts to review the health conditions and health problems of a population, comprising nearly one fifth of the whole human race, and living in a sub-continent which includes almost every variety of climate and custom. You will realise therefore that it is no easy task to summarise events, or to draw any complete picture of widely varying conditions in a brief broad cast talk.

Let me give you, in the first place, just one or two of the almost astronomical figures with which we are concerned. During 1936, nearly 10 million babies were born; there is still no evidence of a fall in the birth rate, which is such a notable feature now a days in most Western countries. In the same period, about $6\frac{1}{4}$ million deaths were recorded. Of this total, over $1\frac{1}{2}$ millions were among infants under one year of age these too, mainly from preventible disease. The love of children is such a marked feature of Indian life, that it has always been to me a matter of surprise that more women of education and leisure have not seen fit to join the voluntary organizations which, for years past have done great pioneer work in the field of maternity and child welfare. Moreover, it is still almost impossible to find young women willing to take up the nursing and health visitors' professions. All this is humanitarian work, which can only be done by women

Apart from humanitarianism, let us look at the high mortality from the purely economic point of view The loss involved in the birth and rearing of great numbers of children, who die before they can make any return to the community, is incalculable. Even a small step in its prevention would have an appreciable effect in increasing the wealth of the country, and, as Mr Harold Butler says, "a courageous attack on the problem might produce a revolution in the standards of life and prosperity".

The report further shows that another 1½ million persons died of malaria, and this disease, without doubt, constitutes India's major health problem. It is no doubt possible to minimise malarial infection in restricted areas, but the problem of India's 800,000 rural villages is quite a different matter. Two years ago, the Government of India made a free gift to the provinces of 15,000 lbs of quinine, and distribution of this drug would seem to be the most practicable method of attack under existing circumstances. As with other health problems, however, the main difficulty is one of cost, although even when quinine is distributed free, it is sometimes difficult to persuade the people to use it. Those of you who have had malaria, will realise that this objection is not without foundation.

Diseases like cholera, plague, small pox, dysentery and malaria, which regularly cause large numbers of deaths, were formerly believed to be a normal feature of tropical countries, a feature which could not be effectively modified. Modern hygiene has proved this to be an entirely erroneous belief. Experience in India, and in other tropical countries, has shown that these diseases can be reduced, and even stamped out, by the application of preventive methods. The health officer in estimating progress must, however, take the long view, and a glance back over the past 31 years makes it clear to me that great improvements have been effected, and that large numbers of lives are now being saved, which would have been lost, if conditions had remained as they were at the end of last century.

New problems, however, arise and the report indicates that tuberculosis has more recently become a serious menace. Careful surveys made of urban and rural populations, have shown that this disease is now causing a high morbidity and mortality. It is essential to organise a wide preventive campaign, if this new danger is to be met, and this will shortly be planned, if a sufficiently generous response is made to Her Excellency Lady Linlithgow's appeal for the King Emperor's fund. In combating tuberculosis, large numbers of special clinics will be required, but education in hygiene, in sound methods of living, and in improved diet, will form an important feature of the campaign.

By subtracting the figure for deaths, from that for births, you get a rough figure of the annual increase in population. In 1936, India's population increased by 3,600,000, and, during 1937, it is probable that a further 4 millions have been added to the total. The primary necessity of the human race is adequate food, and the first step towards betterment of a low standard of living is to increase and improve available food supplies. Both the central Government and provincial Governments have made, and are making, great efforts to develop more scientific agricultural practices, and to provide the additional food supplies required, but the whole question of population and food supply demands the most careful study, not only by politicians, economists and agricultural and health experts, but by every member of the educated community. An improved standard of living is one of India's most fundamental problems.

Closely allied with this question is that of nutrition. It may interest you to know that the Government of India, through the Indian Research Fund Association, has been carrying out nutritional researches for over 20 years past, long before the subject was discussed by the League of Nations, or by other international and national committees. These researches have proved that a vast amount of malnutrition exists in this country, but considerable progress has already been made in the practice of preventive methods. I can mention only one example of our activities. During the past year, a number of health officers from different provinces and States have been trained, at the cost of the central Government, in modern method of investigation and prevention of malnutritional conditions, and these officers have returned to their respective spheres, qualified to put into practice the new knowledge they have acquired. But, of course, nothing is more difficult than to persuade people to change their dietary habits, and much time and effort will be required, before marked progress will be achieved. Here again, education is of primary imp....ice, and provincial and State public departments must accept responsibility for carrying out the necessary propaganda and for extending the general nutritional campaign.

One new section of the present report deals with housing. The importance of housing, in relation to the health of the people, was pointed out years ago, both by the Royal Commission on Agriculture, and, perhaps even more strongly, by the Royal Commission on Labour. In a few restricted areas, commendable efforts have been made, and these have been reflected in the

increased health and happiness of the workers concerned, but, generally speaking, housing conditions both in towns and villages can only be described as deplorable. The individual Indian home is usually kept scrupulously clean, but the villager, like his prototype in other countries, sees nothing objectionable in the accumulation of refuse near his house, nor is he aware of the danger arising from pollution of soil and water. The fundamental improvements required cannot be carried out by legislation alone. These depend mainly on the demand of a higher standard of communal hygiene from the people themselves, and on the development of an educated public opinion. Fortunately, both are now gradually being realised, but side by side with the educational activities now in force, provincial Governments and local and municipal bodies will have to take administrative action, and encourage interest and activity.

Time forbids mention of much else in this annual Report which should appeal to the social student, as well as to the health worker. For instance, one section deals with physical education, which demands far more attention than it has so far received. Other sections include the medical inspection of schools; the health control of fairs and festivals; industrial hygiene; food adulteration, sanitary works and services; the prevention of blindness; the quarantine control of international shipping and air traffic; the part which India plays in international health organisations; and the activities of a number of voluntary organisations interested in different branches of public health work. All these have their own value and importance in the betterment of the health of this country.

It is commonly stated that "health is better than wealth", but I am afraid few give this old truism more than lip service. Is it too much to hope, that what has been said, will stimulate some, at least, of my listeners to take a greter interest, in the health and welfare of their own country and their own people?*

*Broadcast talk on the Public Health Commissioner's Report for 1936, by Col. A. J. H. Russell, C.B.E., I.M.S., Public Health Commissioner with the Government of India

Catalysts of Nutrition

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Catalysts of Nutrition

Although we are well aware of the fact that a food is essential for physiological well-being of the body, yet it would be a revelation to many that the foods which are nowadays being usually consumed, are often deficient in substances that promote our growth and help us in the proper maintenance of the body. In malnutrition these deficiencies occur more in 'good' proteins (as present in milk, fish, egg and meat), vitamins and minerals rather in cereals, fat and carbohydrates, which are the energy yielding foods. Amongst the former an information on the supply of vitamins in our diet is of special significance for the fact that they are present in our food-stuffs in very minute quantities, and are most susceptible to decomposition, deterioration, or loss before any particular food-stuff is actually consumed. Further the amount of any one of them (vide Table I) that is considered to be essential for the body's needs is practically insignificant. For all these reasons the

have been termed "Catalysts" of our nutrition. A knowledge on their more common characteristics, functions in the body, and their sources amongst our food-stuffs, seems then to be of general interest. It may, however, be pointed out here that inspite of the extensive investigations on vitamins for the last few years, we have no definite knowledge on the normal vitamin requirement because there is still no agreed standard as to what constitutes a normal nutrition. The usual accepted figures are as noted in Table I.

TABLE I

Nature of Vitamin	Daily Adult Requirement in mg. (1 mg. 0.0000875 Tola)
A	1.8
B_1	1.5
B_2	2.0
C	50.0
D	0.01

Vitamin A.—It is an unsaturated hydrocarbon sparingly soluble in water, dissolves freely in oils, fat and fat solvents. It is fairly stable towards acids and alkalies. *In the absence of air it is quite stable to heat even at a higher temperature.* But foods that are heated for long periods in presence of air show appreciable loss of vitamin A potency. This is also inactivated by reduction and hence absent in artificial food fats. Carotene, an orange coloured pigment found in carrots and green plants, is the precursor of vitamin A and is converted to it when eaten by animal beings. The international unit (standard) is the vitamin activity of 0.6 gamma of pure β-Carotene (gamma 0.001 mg.).

Vitamin A promotes growth and appetite. It is essential for reproduction, lactation and protection against eye affections including night blindness. It increases the resistance to infections of respiratory tract and intestines. An adult requires about 2000 to 4000 international units, or, in average about 1.8 mg. of β Carotene. But 5000 international units are being recommended for pregnant and nursing women. The Table II shows the approximate amount of a food-stuff that would supply the average adult daily requirement. From the Table it would be evident that certain food-stuffs are excellent sources and others are fairly good.

TABLE II (VITAMIN A)

Food-stuff	Amount in Tolas
Liver, sheep	1.2
Coriander leaves	2.0
Curry leaves	2.0
Pepper red	2.1
Drum stick	2.3
Betel leaves	2.7
Apricot	3.5
Celery leaves	4.0
Butter	5.0
Mango, ripe	5.5
Peas, green	25.6
Soyabean	37.0
Dates	43.7
Jack fruit	50.0
Lentil	58.0
Bananas	75.0
Orange Juice	80.0
Tomato ripe	82.0
Bengal gram	83.0
Mustard seed	97.0
Neem tender	5.7
Potato, sweet	6.5
Fenu greek	7.0
Parsley	8.2
Mint	9.7
Spinach	10.0
Lettuce	12.0
Carrots	13.0
Cabbage	13.0
Papaya	13.0
Coriander	16.8
Eggs	21.5
Peper, green	25.0
Beans, fresh	120.0
Red gram	120.0
Gourd	125.0
Wheat, whole	143.0
Green gram	169.0
Mango, green	175.0
Oysters	187.5
Apple	251.0
Guava	262.5
Tamarind	262.5
Pine apple	262.5
Cauli flower	375.0
Potato	469.0

Vitamin B_1. This is a basic substance readily forming hydrochlorides and bromides soluble in water but insoluble in oils. It is stable towards atmosphere oxidation but is mechanically lost in refining of food materials, or after, in the discard of water in which the food materials are soaked (hence lost in certain milled rice, with rice soup etc.). It is not destroyed during the process of cooking unless the natural acidity of the food is reduced by the addition of any alkaline material. The international unit is the activity of 5 gammas of the crystalline vitamin. This has now been chemically synthesized.

This vitamin promotes appetite and digestion, prevents us from nerve diseases like beri beri, and is essential for growth, vigour and during pregnancy and lactation. The daily human requirement is about 300 international units. But the amount of the vitamin necessary depends on the age, weight and upon the caloric value of the food consumed by any individual. The requirements of children are however greater in proportion to body weight, and during pregnancy and lactation women would need from three to five times the normal requirement. The body does not store large quantities of vitamin B_1 and any excess over normal requirement is rapidly excreted in the urine. For this large doses of the vitamin are not toxic to human beings. The food stuffs that would supply the average adult requirement are recorded below.

TABLE III (VITAMIN B_1)

Food-stuff	Amount in Tolas
Wheat germ	2.2
Soyabean	8.75
Ground nut	8.75
Wheat whole	11.4
Red gram	13.8
Green gram	17.0
Walnut	17.5
Barley	17.5
Lentil	17.5
Black gram	18.7
Liver, sheep	21.8
Cauli flower	24.0
Rice brown	26.25

TABLE III (VITAMIN B_1)—*Contd.*

Food stuff	Amount in Tolas
Mint	29.0
Milk	30.0
Spinach	37.0
Cabbage	52.5
Bananas	52.5
Eggs	58.0
Plums	65.0
Onion	65.0
Apple	65.0
Grape	65.0
Carrot	65.0
Orange juice	87.0
Potatoes	96.0
Potatoes, sweet	117.0
Tomato, ripe	125.0
Beans, green	131.0
Pine apples	125.0
Ladies', fingers	125.0

Vitamin B_2.—Vitamin B_2 is a greenish yellow substance soluble in water, dilute alcohol, but insoluble in oil solvents. This, specially in presence of acids, is stable to heat. On exposure to ultra violet light radiation it is slowly destroyed. It has been isolated from milk, egg and liver, and has even been synthesized and is now termed " Riboflavin ". There is no international standard. Bourquin-sherman unit is generally accepted and is found to coincide with 3 to 5 gammas of the synthesized product.

It is essential for growth and in maintaining a healthy condition of the skin. The soreness of the angles of the mouth and tongue is believed to be due to its deficiency. It also helps in the preventation of digestive disturbances, nerves depression and general weakness. An adult requires about 400 to 600 Bourquin-Sherman units, or roughly 2.0 mgm. of riboflavin. It has been found that if the intake of the vitamin is low, the amount excreted exceeds the intake; on the contrary if large amounts are taken the excretion is less than the intake. The food stuffs that would supply the usual requirement, would be found in Table IV.

TABLE IV (VITAMIN B_2)

Food stuff			Amount in Tolas
Liver	..	..	4.4
Soyabean	..	..	4.9
Turnip, green	..	..	14.5
Spinach	..	..	33.3
Eggs	..	..	34.9
Wheat, whole	..	..	48.3
Rice polishings	..	..	60.6
Cauli flower ..	..	..	65.6
Peas, fresh ..	..	..	72.9
Carrots	..	..	84.1
Beans, fresh ..	..	..	87.5
Milk	..	..	91.7
Cabbage	..	..	97.5
Apricot	..	..	109.0
Potato sweet	..	..	127.0
Papaya	..	..	133.3
Bananas	..	..	141.6
Pine apples ..	..	..	171.9
Orange juice	..	..	179.1
Potato	..	..	218.7
Tomato ripe ..	..	..	291.6

Vitamin C.- It is a sugar acid easily soluble in water and sparingly in fat solvents. It is more stable in acid solution and in the dry state. Being a strong reducing agent it readily undergoes decomposition in presence of air. Thus potatoes in about 3 weeks lose 60% of its vitamin C content, and spinach in 3 days about 80 per cent. It is also sensitive to heat and is destroyed during cooking. About 33 per cent of vitamin C of tomatoes, 75 per cent of spinach and 60 per cent of peas are lost by cooking. It is therefore better to cook vegetables believed to be cantaining vitamin C, in absence of air. The international unit is 0.05 mgm. of pure crystalline vitamin C (*l*--ascorbic acid).

This is necessary in the oxidation process of cells, for proper formation of bone and teeth, and to prevent scurvy. A deficiency of the vitamin brings forth a great lassitude. The average adult requires from 25 to 75 mgm. daily. In certain pathological conditions such as pregnancy, lactation period, old age etc. as well as in certain diseases, the requirement of the vitamin is considerably increased. Toxic effects from the use of a large dose of this substance are most unlikely as it is rapidly eliminated in the urine. The food-stuffs that would supply the average adult requirement on 50 mgm. basis, are enlisted in the following Table V.

TABLE V (VITAMIN C)

Food-stuff			Amount in Tolas
Guava	..	..	1.5
Mango, ripe ..	..	..	1.87
Coriander	..	..	3.25
Pepper, green	..	..	3.50
Cabbage	..	..	3.5
Drumstick	..	..	3.75
Chillies, green	..	..	4.4
Cauli flower ..	..	..	6.62
Pine apple	..	..	7.0
Bitter gourd ..	..	..	5.0
Mung, germinated	.	..	6.25
Chillies, dry	..	..	8.62
Beans, green ..	..	..	8.75
Spinach	..	..	9.12
Papaya	..	..	9.62
Turnips	..	..	10.1
Lemons	..	..	11.25
Liver	..	..	12.5
Bengal gram, germinated		..	12.5
Tomato	..	..	13.62
Grape fruit ..	..	..	13.75
Peas, green ..	..	..	15.0
Potato, sweet	..	..	18.25
Plantain, green	..	..	18.37
Brinjal	..	..	19.37
Potato	..	..	25.75
Lettuce	..	..	29.12
Onion	..	..	41.62
Bananas	..	..	43.75
Cucumber	..	..	62.5
Betel leaves ..	..	..	91.25
Apple	..	..	212.5

Vitamin D. This occurs in several forms, but all are polycyclic unsaturated hydrocarbons easily soluble in oils and fats but insoluble in water. It is sufficiently stable to heat but decomposes on irradiation and hence should be protected from light. It is stable towards

alkalies but in acid medium gradual decomposition takes place. The standard contains 0.025 gamma of "Calciferol" the official name of the vitamin. The daily requirement is influenced by age, colour and other conditions. Thus during growth and during pregnancy about 1000 units are required, whereas an adult might require on average about 400 international units *i.e.*, about 10 gammas of calciferol. But the constant synthesis of vitamin D in the skin under the influence of sunlight renders it difficult to ascertain its daily requirement from clinical tests.

This vitamin is absolutely essential for the absorption and metabolism of the bone forming elements, calcium and phosphorus. It prevents rickets and decalcification of the skeleton developing during the later months of pregnancy. Ordinary food-stuffs are very deficient in vitamin D. Fruits and seeds contain no vitamin. It is, however, produced in the skin when exposed to sun light sun high up in the sky, and in dust and smoke free atmosphere. Amongst the food-stuffs only fish, eggs, milk, butter and liver contain certain amounts of vitamin D activity. The potency again varies considerably. Thus, eggs may supply the daily requirement in amounts ranging from 20 to 230 tolas, or the egg yolk in quantities varying between 7 to about 24 tolas. An over dosage of this vitamin often produces nausea and vomitting, and loss of weight. The toxicity and the other side affects of the vitamin D, may however, be removed or diminished by an abundant supply of vitamins A, B_1 and C. This toxicity is often found to be due to the use of irradiated ergosterol products which contain toxic substances, such as toxisterol.

Vitamin E. This is a substance that is being found in the unsaponifiable fraction of the fat and oil of certain substances. It is stable to heat, cooking, light, acids and alkalies, but is inactivated by oxidation. The activity is also destroyed when rancidity develops in the fat or oil carrier. Still it is one of the most stable vitamins as even hydrogenation seems to have no destructive influence. The exact chemical nature, or any standard has not yet been ascertained.

The vitamin is essential for normal reproduction function both for males and females. Its absence causes sterility. The daily requirement is not known but the relative activity of a number of food materials has been investigated. In the Table VI, such stuffs which are either good or fair sources of the vitamin, have been enlisted.

TABLE VI (VITAMIN E)

Good	Fair
Lettuce	Barley
Water cress	Beans
Wheat germ	Egg
	Milk
	Molasses
	Peas, fresh
	Rice, whole
	Vegetable oils
	Wheat, whole.

It must be remembered that a food may be a good source of a particular vitamin, but that does not mean that its potency would remain unimpaired. From the characteristics of any of the vitamins just discussed, it is quite reasonable to believe that before a food comes to our dining table it might have gone such treatment that little or none of its vitamin potency would be left. Besides this, a particular food even may vary in its potency. Thus, eggs and milk are excellent sources of vitamin A, but as the animals do not seem to be capable of synthesizing the vitamin or its precursor carotene, they would depend on their food, specially succulent green grass, for the needed supply. Naturally, therefore, the vitamin A activity of the above two products would vary according to the quantity and amount of vitamin A in the diet of the species in question, when it would be a reasonable guide to select the fodder properly and correctly in order to have a better type of the food material. Actually the vitamin A content of milk is generally found to vary in such a way that the daily adult requirement might be available from about 40 to 190 tolas of milk. Again one may not prefer to take eggs. Under this circumstances fish may be consumed as the liver oils of some of the common fishes, *Ruhee, Vetki*, are rich in vitamin. We should also select an amount (about 2 chattaks) of green leafy vegetables (*shak*) with our dietary as the carotene present in them would be converted to vitamin A in our bodies.

Similarly though rice and wheat are two fine sources of vitamin B_1, the table rice or the fine flour in spite of their attractive looking, are usually devoid of their much valuable substances. For this the poor people suffer most as they generally take mo

carbo-hydrate-rich diets, and consequently their requirements of vitamin B_1 too are greater. The diet in the households of these poorer classes would be much improved if home pounded rice or whole meal wheat be consumed by them. Consequently for the interest of the general public, the guiding principle for the mill owners should be to devise means by which the rice or wheat be so treated that a minimum amount of vitamin B_1 and other mineral elements may be lost during the removal of the outer coatings of the grains. In the alternative we have to seek for other substances rich in vitamin B_1, or to purchase its concentrate; which should then be available even in a grocer's shop. In the meantime we should be cautious in the rejection of cooking waters from cereals and vegetables as they contain much valuable nutritive substances. Regarding vitamin B_2 (riboflavin) it may be said that the ordinary grams, *chola, mung, arhar,* are very excellent sources but a greater part of the vitamin is rejected in the milling of the grain. There exists an inverse relationship between the intake and excretion of this vitamin, so it would be better to take sufficient amount when the body would store it for utilizing the reserve in times of deficiency. For vitamin C we should always take some fresh fruits, specially of the citrus varieties, or vegetables, remembering that vitamin C content of these substances is considerably reduced on storing and cooking. The daily intake of an adequate amount is more necessary because the human body is not capable of storing large quantities of the vitamin. Lastly it may be pointed out again that the ordinary food-stuffs are very deficient in vitamin D. But the sun light is the cheapest source. It is, however, difficult to enjoy a clear sun shine in any modern city whose atmosphere is usually polluted with smoke and dust. For these it would be better for those living in a metropolis to leave the city and spend their time in any rural area for a number of works during a year.

One may now question, "Are we then the victims of modern civilization and its scientific development?" But there is hardly a scientific discovery of practical application that cannot be used destructively as well as constructively. A scientist discovers a thing as a result of satisfying his intellectual curiosity. This discovery may ultimately be utilized for some commercial purpose. But the mode of its application would depend on the nature or character of the people who put the same to the service of the public. Thus, the hydrogenation process has opened up the possibility of converting the odorous fish oils and undesirable vegetable oils into soap of everyday use, and the discoverer of the process is certainly not responsible if the same hydrogenated oil or fat be used for adulterating the common butter or ghee. Of course, with the development of modern civilization and consequent adoptation to an industrial and artificial life it is not possible for most of us to follow the earlier system of living and to partake of fresh vegetables from our own garden, fresh fishes from the pond and fresh fruits during all the twelve calender months. It is not always practicable to enrich our dietary according to our choice and palate. But still with a better knowledge of nutrition we may adjust our diet that would not only supply the energy but help us in protecting from deficiency diseases like rickets, scurvy, beri-beri, or dental caries.

The practical problem of food selection is really influenced by several factors. But in selecting our food-stuffs we are generally guided by palate, custom or fashion has also no scientific basis. No one would now guide in the case of vitamins; some prefer a particular food but the some again is disliked by many. Custom or fashion has also no scientific basis. No one would nowadays prefer to take a few germinated grams, moistened *chira* (beaten rice), or similar other thing, but would gladly consume a toast made up from refined white flour and the so-called butter. Even in holidays we would not like to take '*gala-bhat*' (rice with soup) with a boiled potato, but run down to the nearest shop to purchase some palatable sweetmeats. We do not care to enlist leafy vegetables and certain fruits in our dietary, but furnish the side-board with adulterated mustards, jam or jelly. On the other hand we are gradually increasing our expenditure, which is sometimes superfluous, on clothes and other accessories. Do we spend the requisite portion of our income for food? The general tendency is to make a cut in the food expenditure in order to keep pace with modern fashion. Indeed the nutritional problem is mainly a problem of income, and the economic considerations and the family resources are mostly responsible for malnutrition. Still it considerably depends on the degree of urbanization and on proper knowledge of food and nutrition. Remembering that a deficiency in vitamins and minerals is extremely deterimental to health, one may try to have a good planning of his dietary and adjust his budget accordingly to spend more money for his foods.

RESEARCH NOTES

Wilson Chamber Tracks of Heavy Electrons

Cloud chamber tracks in which the specific ionization was greater than that produced by a fast electron and the values of $H\rho$ were smaller than those in a track due to a fast proton were photographed and identified to be due to heavy electrons, first by Neddermeyer and Anderson (*Phys. Rev. 51*, 884, 1937) while taking photographs of cosmic ray tracks in Wilson Chamber. Since then, tracks due to such heavy particles charged positively in some cases and negatively in other cases have been observed by several workers. The charge on these particles has been found to be equal to that of an electron or a positron and the mass, as determined from considerations of the values of range and $H\rho$, or of specific ionization and $H\rho$, by Street and Stevenson (*Phys. Rev. 52*, 1937), Nishina Takeuchi and Ichimiya, (*Phys. Rev. 52*, 1937), Corson and Brode (*Phys. Rev. 53*, 1938), Ehrenfest, (*Comptes Rendus, 206*, 1938), Blackett (*Proc. Roy Soc.*, 165, 1938), William and Pickup, (*Nature*, 141, 1938), Ruhlig and Crane (*Phys. Rev. 53*, 1938) and Neddermeyer and Anderson (*Phys. Rev. 54*, 1938), varies from $50m_0$ to $430m_0$, where m_0 is the mass of the ordinary electron.

Recently some photographs of cloud chamber tracks due to heavy electrons have been published by Maier-Leibnitz (*Naturwiss., 26*, October, 14, 1938). There are some special features exhibited by some of these tracks, which are significant from theoretical point of view. Theoretically a heavy electron can be transformed into an ordinary electron and a neutrino. Positive experimental evidence of such a transformation has not been observed before. One of the photographs published by Maier-Leibnitz clearly indicates that a heavy positron emerging from a foil placed in the middle of the Wilson Chamber goes through a short distance along almost a straight track and then is suddenly transformed into an ordinary slow positron which moves along a curved path in the magnetic field and produces a specific ionization agreeing well with that produced by an ordinary positron. Considering the energy of the heavy positron and that of the ordinary positron into which the former is transformed, it is found that the heavy positron, after emitting a neutron and the light positron, is transformed into an uncharged heavy particle. Such a transformation is also in accordance with the expectations from theoretical point of view.

S. S.

Chemical Topography of the Brain

In any attempt to relate function of the brain to chemical composition, a systematic examination of the chemical constituents of a large number of brains has to be performed before any generalization could be made from the results. Such studies had been made by Mac Arthur and Doisy, Tilney and Rosett, Koch and Voegtlin. But their findings were based on insufficient number of brains to warrant any generalization. Recently L. O. Randall (*J. Biol. Chem., 124*, 418, 1938) has analysed twenty three brains from normal and psychotic subjects.

The distribution of eighteen chemical constituents in the following topographical areas was determined: corona radiata, frontal white, parietal white, brain stem, thalamus, caudate nucleus, frontal cortex, and parietal cortex.

The constituents measured in the various topographical areas were as follows: water, phospholipid, acetone soluble lipid, total lipid, total cholesterol

free cholesterol, phospholipid fatty acid, iodine number of the phospholipid fatty acid, lipoid phosphorous, acid soluble phosphorous, ester phosphorous, inorganic phosphorous, creatine, total nitrogen, lipid nitrogen, acid soluble nitrogen, and protein nitrogen.

The right hemisphere was used for all analyses. As soon as the brain was received, within 6 hours *post mortem*, the various topographical areas were dissected out and the tissues placed on solid CO_2 till they could be sampled. The frozen tissues were thawed at room temperature, ground in a mortar, and placed in a weighing bottle. Aliquots were taken for the determination of water, lipid fractions, acid soluble fractions and total nitrogen.

The brains analysed were taken from seven normal, ten Schizophrenic, two mentally defective, and four arteriosclerotic subjects. The age range was from 28 years to 82 years. The deaths were due to pulmonary, cardiorenal, and accidental causes.

Of the various lipid constituents, the author finds that total lipid, acetone soluble lipid, total cholesterol, free cholesterol, phospholipid, phoslipid fatty acid, lipoid phosphorous, and lipid nitrogen are higher in the white areas than in the gray areas and intermediate in the mixed areas.

The iodine number of the phospholipid fatty acids is higher in gray than in white tissues.

The acid soluble nitrogen, creatine inorganic phosphorous, protein nitrogen, and total nitrogen are higher in gray than in white tissues and are intermediate in the mixed tissues.

Only acid soluble phosphorous and ester phosphorous have a similar distribution over all the areas.

H. N. B.

Two-body Problem in Relativity Mechanics

When there are two bodies in space, each will have its motion controlled by the other. A complete mathematical description of their motions is known to astronomers as *two-body problem*. It is known that a large number of stars in the sky though looking single are really twins. The problem of the motion of such binary stars is in fact a two-body problem. Classical Newtonian mechanics has succeeded in reducing the problem of *two* bodies to a problem of *one* body moving under attraction from a centre. It is able to describe simply and accurately the motion of one body as it will appear to an observer in the other. Thus classical mechanics reduces the problem of two bodies to *one of relative motion*. An important characteristic of such motions is that the centre of gravity of the masses moves uniformly in a straight line without acceleration.

Attempts have been made to study the problem of two bodies from the point of view of Einstein's Theory of Relativity in the hope that some additional light might possibly be thrown on the characteristics of the motion. But unfortunately like the three-body problem of classical mechanics, the two-body problem of Relativity Mechanics has as yet defied all attempts at a rigorous solution. The problem has to be solved by the method of successive approximations such that the solution thus obtained may in the Newtonian approximation correspond to the known solution of the two-body problem in classical mechanics.

Recently Levi-Civita in this manner obtained (*Amer. Jour. Math. 59* p. 9-22 and p. 225-34, 1937) an approximate solution; and arrived at the conclusion that the centre of gravity of a binary star has a net slow acceleration. His result implies that a binary star as a whole describes a circle of very large radius in space, and further the acceleration referred to above may be detectable in a period much less than a century, probably within a few years, a conclusion which must have surprised many astronomers.

There are no obvious reasons to reject Levi-Cevita's result as inadmissible. But it was so striking as to rouse suspicion in many of the leading astronomers and scientists. The problem was reconsidered on the one hand by Eddington, who working in collaboration with Clark by a method different from Levi-Civita's arrived at a contrary conclusion (*Proc. Roy. Soc. A 166*, p. 465-75), namely the centre of gravity has no net slow (secular) acceleration. On the other hand Einstein himself in collaboration with Infeld and Hoffmann has developed (*Ann. Math. 39*, p. 65-100) a comprehensive

method of approximate calculations for a large number of bodies, and Robertson by working up this scheme for binary stars has arrived (*Ann. Math.* *39*, p. 101-4) at the same conclusion as that of Eddington. It is believed Levi-Civita's originally contrary result is probably due to a numerical slip. As *yet* the conclusion of classical mechanics is entirely supported by Relativity.

It is to be noted, however, that all these solutions, as we have already observed, are approximate where only terms up to the order of $1/c^4$, where c is the velocity of light, have been retained. Retention of terms which are small quantities of higher order may still lead to the existence of a very slow acceleration. Moreover, Eddington has pointed out that such net slow acceleration would imply radiation of momentum through gravitational waves by the moving body. It is known from the previous works of Einstein (*Berl. Sitz.* p. 688, 1916 and p. 154, 1918) and Eddington (*Proc. Roy. Soc.* A 102, p. 268) that in the ideal case of a spinning rod there exists a radiation of momentum of third order (*i.e.*, of the order of $1/c^6$), so that after all a secular acceleration of *third order* in the case of a binary star may be a possibility.

B. C. M.

Production of Artificial Auroras in the Upper Atmosphere

Prof. V. A. Bailey of Sydney has suggested a novel use of electromagnetic waves. According to Prof. Bailey, radio waves radiated by a sufficiently powerful transmitting station may, under certain circumstances, excite artificial auroras in the upper atmosphere. He suggests (*Nature*, October 1, 1938) that in latitudes where the terrestrial magnetic field is nearly vertical, a visible glow discharge can be produced by means of a vertical beam of circularly polarized waves, the frequencies of which are approximately equal to the local gyro-frequency (*i.e.*, the frequency of gyration of a free electron in the earth's magnetic field), the energy being radiated at the rate of 500 kilowatts from a suitably designed aerial system consisting of 800 horizontal half-wave aerials situated about one quarter of a gyrowavelength above the ground and spread over an area of about 2 sq. kms. The importance of such artificial auroras can hardly be over-emphasized. For these would allow spectroscopic and other studies of the region round the lower part of the E layer (90 km.) to be made entirely at the control of the observer. Prof. Bailey also suggests that the existing high power radio stations (500 kilowatt) at Cincinnati or at Moscow may be utilised for an attempt to produce such artificial auroras. He concludes that with an aerial array similar to the one indicated above and with gyro-waves radiated at the rate of one million kilowatts it is possible to provide an illumination of 0.02 foot candles over an area of about 10,000 square kilometres round the transmitting station. The illumination is approximately equal to that produced on clear nights by the full moon when overhead and is sufficient to fulfil the minimum requirements prescribed for the lighting of roadways.

J. N. B

University and Academy News

Mining, Geological and Metallurgical Institute of India

(Asansol, 21st November, 1938)

(1) 'Methods of Stowing for Indian Mines' By J. Thomas.

(2) 'Notes on Methods of detection and dealing with 'heatings' and fires in Coal Mines' By E. B. Park.

The National Academy of Sciences, India

(Allahabad, 29th November, 1938)

(1) Osculating quadrics of a Ruled surface By Dr Ram Behari.

The Council awarded the Education Minister's gold medal, which has been so kindly placed at the disposal of the Academy by the Hon'ble Mr Sampurnanand to Prof. Birbal Sahni, D.Sc., F.R.S., Lucknow University, for his paper entitled "Materials for a Monograph of the Indian Petrified Palms."

Prof. J. H. Mitter, Prof. A. C. Banerji, The Hon'ble Sir Shah Muhammad Sulaiman, Dr D. S. Kothari and Dr H. R. Mehra were nominated delegates to represent the Academy at the forthcoming session of the Indian Science Congress.

Prof. K. N. Bahl, D.Sc., D.Phil. was congratulated on the conferment of the D.Sc., degrees of the University of Oxford on him for his valuable contributions to the advancement of scientific knowledge.

The following were elected fellows: Dr Ram Behari, M.A., Ph.D., Reader in Mathematics, University of Delhi, and Mr Saradindu Basu, M.Sc., Meteorologist, Upper Air Observatory, Agra.

Calcutta Mathematical Society

(Calcutta, 15th December, 1938)

(1) Vector theory of non coplanar forces—By H. Bagchi.

(2) Affine rolling of first kind - By A. C. Chowdhury.

(3) A self reciprocal function By R. V. Sastry.

Indian Chemical Society

(Calcutta, September, 1938)

(1) A Method for the estimation of cobalt in presence of nickel. By Dines Chandra Sen.

(2) Use of vanadous sulphate as a reducing agent. Part III. Estimation of cerium. By Pares Chandra Banerjee.

(3) Viscosity and density of cadmium chloride solutions at 35°. By Amritansu Sekhar Chakravarti and Balbhadra Prasad.

(4) On the moving boundary method for the determination of cataphoresis of colloids. By N. C. Sen Gupta.

(5) Strainless monocyclic rings. Part III. Synthesis of 2-Methyl cyclohexane succinic acid and the separation of its isomers. By Muhammad Qudrat-i-khuda, Akbar Ali Mallick (in part) and Ashutosh Mukherji.

(6) Studies in organo-arsenic compounds. Part VIII. Synthesis of arsindole derivatives from phenylacetylene.—By Hirendra Nath Das-Gupta.

(7) Studies in organo-arsenic compounds. Part IV. Synthesis of arsenic analogue of succinimide.- By Hirendra Nath Das-Gupta.

(8) Indigoid vat dyes of the isatin series. Part III. 3 Indole 2′-(4′-methyl)-thionaphtheneindigos.—By Sisir Kumar Guha.

(9) Essential oil from flower kewda (*Pandanus Odoratissimus*).—By S. S. Deshapande.

(10) On certain salts of Alkaloids. By U. P. Basu.

(11) Occurrence of psoralen in *Phebalium Argentum*, Smith. By P. K. Bose and H. H. Finlayson.

Indian Chemical Society

(Calcutta, 25th November, 1938)

The following gentlemen were admitted as fellows:

Mr N. P. Datta, and Mr P. N. Bagchi.

The following gentlemen were elected as fellows of the Society.

Mr B. G. Acharya (Bombay); Mr S. S. De (Calcutta); Dr H. K. Nandi (Assam) and Mr K. N. Mana (Thamel, Nepal).

The next Annual General Meeting of the Society will be held on the 4th January, 1939 at Lahore at 2-30 p.m. at the Chemistry Section Meeting Room of the Indian Science Congress.

Royal Institute of Science, Bombay

Prof. G. R. Paranjpe has assumed charge as Principal of the Institute vice Dr T. S. Wheeler on leave. Dr R. C. Shah has been appointed to do duty as Professor of Organic Chemistry in place of Dr T. S. Wheeler. Dr (Miss) Banoo Khambatta has been appointed as an additional Assistant Lecturer in Chemistry. Dr Karandikar has taken the place of Mr Bal (on leave in England) as Assistant Lecturer in the Zoology Department.

The University of Bombay has nominated Dr N. R. Tawde, of the Physics Department as one its delegates to the ensuing 26th Session of the Indian Science Congress to be held at Lahore in January 1939. The Director of Public Instruction has allowed Dr Mata Prasad, Dr F. R. Bharucha and Dr R. C. Shah from the Institute to attend the session of the Indian Science Congress, 1939.

Research Work in India

(Science College, Patna, 1937-38)

The investigations carried out or in progress during the year 1937-38, in the Physics laboratories of the Science College, Patna, related to problems connected with properties of matter, electricity, refractometry, spectroscopy, X-rays and wireless, a short account of which is given below:—

Properties of Matter—The laws of spreading of filter paper have been developed and verified by a very large number of experiments with drops of different sizes of pure organic liquids and electrolytic solutions. (*Kolloid Zeitschrift*, *79*, 19, 1937 and *84*, 275, 1938).

Electricity—It has been found possible to determine the average size of the ash particles from a theoretical and experimental study of the trajectory of cigar ash particles shot out from an orifice by effluent air under measured driving pressure. The method may be extended to the study of the general problem of smokes and aerosols under different conditions. (*Phil. Mag.* *25*, 993, 1938).

The variation of the dielectric constant of space containing electrons when subjected to an alternating high frequency electric field has been studied. A modified formula was suggested to explain quantitatively the results obtained as the simple Larmor theory had failed to do so. (*Zeitschrift fur Physik*, *107*, 441, 1937).

It is well established that mechanical pressure on a photographic plate leaves an impression when developed and this is known as 'pressure effect.' An investigation has been attempted to see how far the ejection of the electrons can serve as a physical basis for the 'pressure effect.' (*Ind. Jour. Physics*, *11*, 289, 1937).

Refractometry—A ray-displacement refractometer was devised to measure accurately the refractive indices of thin transparent plates of small sizes and also of liquids. This refractometer has been employed to study the anomalous dispersion of a specimen of didymium glass whose absorption bands had been previously investigated here (*Ind. Jour. Phys.* *11*, 13, 1937).

Spectroscopy Spectum of Barium has been obtained by the condensed discharge method and also by the electrodeless glow. Attempts are being made to account for the lines which still remain unclassified. (*Bulletin Pat. Sc. Coll. Phil. Soc.* 8 241, 1938).

Intensity and structure changes of the $L\alpha$ emission lines of Cu, Fe and Al on intense cooling of their anticathodes have been investigated in a preliminary way. Detailed investigation with a grating of higher dispersion has also been partially completed. (*Nature*, *140*, 464, 1937).

A number of some semi-optical lines in the K, L and M series of X ray spectra have been selected from the available experimental data and possible explanations of their origin have been attempted. (*Ind. Jour. Phys. 11*, 77, 1937).

X-rays· Electro deposited chromium and gold have been studied by the X-ray powder method and the correlations between current density and selective orientation, and between hardness and breadth of diffracted lines have been investigated. (*Ind. Jour. Phys. 11*, 219, 1937).

Using X-ray reflection spectra from a crystal of rock salt raised to different temperatures, the coefficients of linear expansion of the material within the range 30°C to 450°C have been determined. Attention has been drawn to the different values of the constant dependent on the definition adopted. (*Ind. Jour. Phys. 12*, 1938 in the press).

Wireless· An apparatus for obtaining hourly automatic photographic records of the strength of the received signals over a considerable period has been set up; and a study of the variation of the field strength of distant transmitting stations is in progress. (*Bulletin. Pat. Sc. Coll. Phil. Soc. 8*, 236, 1938).

New Fellows of the National Institute of Sciences of India

R. Gopala Aiyar—He was awarded the Curzon Prize for original research by the Madras University. In 1925 he was appointed Professor of Zoology at the Maharajah's College, Ernakulam. He served as a member of the Madras University Commission in the year 1928. From 1929-33 he was Additional Professor of Zoology at the Presidency College, Madras. He had been Chairman of the Board of Studies in Zoology of the Madras University and other universities for several years. In the year 1933, he presided over the Zoology Section of the Indian Science Congress, and in the year 1937, was President of the Madras Science Club. Prof. Aiyar is the Director of the University Zoological Research Laboratory of Madras and is President of the Faculty of Science of the University of Madras. He is author of several papers, some independently and some in collaboration, on marine biology and cytology.

J. B. Auden Born at York, England, in December 1903, Mr J. B Auden was educated at Marlborough and Christ's College, Cambridge, and joined the Geological Survey of India in November, 1926. After working in the Raniganj Coalfield, he mapped an area of Vindhyan rocks and published a *Memoir* on Vindhyan Sedimentation. Most of his time has been spent in the Himalayas, and his paper in *Records, Geol. Surv. India. 71*, Pt. 4, 1937 summarises his present views on the Tectonics of the Garhwal Himalaya. He has made various expeditions, some on duty and some on furlough, to the main ranges of the Himalaya and the Karakoram, accounts of which have appeared in the *Himalayan Journal*. In association with other members of the Geological Survey, he was connected with an examination of the Bihar Nepal Earthquake, and was allowed to visit certain parts of the Nepal Himalaya.

N. K. Bose --Born in March 1896 at Mymensingh, Bengal, Dr N. K. Bose, was educated at Uttarpara and in the Presidency College, Calcutta, and passed the M.Sc., examination in Applied Mathematics. He worked on aerodynamical problems for some time with the Ghose Professor of Applied Mathematics in the University College of Science, Calcutta. He joined the Mathematics Department of the Dacca University in 1921 as Assistant Lecturer, but in September, 1922 left for Germany and joined University of Göttingen. He worked there with Prof. L. Prandtl of the Kaiser Wilhelm Institute of Aerodynamic Research, and was awarded the Degree of Doctor of Philosophy (Class " Sehr Gut " Very Good) in 1922. After his return to India he was Reader in Mathematics in the University of Aligarh for some years. In 1925 he was awarded the Griffith Prize by the Calcutta University and joined the Punjab Irrigation Research Institute, Lahore, in January 1927 as Mathematical Adviser to the Irrigation Department and was sent immediately on deputation to Budapest for training in the use of Eötuös Torsion Balance. He carried out extensive surveys in the

Punjab during the winter of 1927-28, 28-29, and 29-30. He was also responsible for the solution of the problem of safety of weirs on sand foundation whose results are published in the *Design of Weirs on Permeable Foundations*. The Trimmu Weir of the Haveli Project of the Punjab Irrigation has been designed on these principles.

In recent years he has been busy with model experiments on hydraulic problems. In connection with the Haveli Project he carried out a series of model experiments on river training, silt exclusion and Falls.

In 1937-38 he officiated as the Director, Punjab Irrigation Research. He has nineteen papers to his credit contributed to the various foreign and Indian journals.

J. K. Chowdhury Born in 1892 at Lamchar, Bengal, Dr Jogendra Kumar Chowdhury, was educated at Comilla, Krishnath College, Berhampore and the Presidency College, Calcutta, where he came into personal touch with Sir P. C. Roy. He served the Assam Oil Co. Ltd. of Digboi for some time and in 1921, he proceeded to Germany for further study in applied chemistry and worked at the Technische Hochschule of Charlotenburg and the Kaiser Wilhelm Institut for Fibre chemistry at Dahlem, under Prof. Dr R. O. Herzog, and published a paper on 'Ethers of cellulose with oxyacids.' After visiting a large number of important factories all over Germany, he came back to India and in 1925 was appointed Reader in Chemistry in the University of Dacca, and placed in charge of the Applied Chemistry Section.

At Dacca, Dr Chowdhury undertook the investigation of jute fibre, and has, since 1927, published a serious of papers on the subject in the *Journal of Indian Chemical Society*. He has improved the fibre qualities of jute by various treatments, threw a flood of light on the nature of its various constituents such as cellulose, lignin, hemicelluloses and uronic acids, and also interpreted the physical and chemical behaviour of the fibre in the light of its chemical constitution. Dr Barker in his report on Scientific and Technical Development of the Jute Industry in Bengal, commented very favourably on these fundamental investigations. Dr Chowdhury and his students have shown that mixed adsorbents are more active than their components and are therefore eminently suitable for industrial operations such as recovery of solvents or of benzol from gases, the refining of vegetable and mineral oils etc.

Catalytic Oxidation of various hydrocarbons has also been studied in his laboratory, and conditions for optimum yield of pthalic and benzoic acids from naphthalene and toluene respectively have been determined and a mechanism of the process of oxidation of various hydrocarbons has been suggested on the basis of various intermediate products indentified.

He and his students have polymerised unsaturated fatty acids and has obtained mineral lubricating oils by decarboxylating the product. They have also obtained interesting results from an analysis of the Oil of *Rohita* a fresh water fish found in Bengal and have found in it acids of the formulae $C_{24}H_{38}O_2$ and $C_{16}H_{30}O_2$ in appreciable amounts.

He has been elected member of the Council of the Indian Chemical Society for several terms and is a member of the board of editional correspondents of the Industrial and News Edition of the journal of this society.

H. Crookshank Born in 1893 in Dublin, Mr H Crookshank entered Trinity College, Dublin in 1911, enlisted in the army in September 1914, served in the machine gun section of the 7th Royal Dublin Fusiliers in Gallipoli and was wounded there. Later served as a lieutenant in the Royal Engineers in Egypt, Palestine, and France and was mentioned in despatches twice. He returned to Trinity College soon after the armistice and took the degree in engineering in July 1920. He was appointed Assistant Superintendent, Geological Survey of India in December 1920 and Superintending Geologist in November 1935.

His work has been mainly mapping, in Rajputana, Madras, the Central Provinces and Bastar State.

He has published eight papers mostly in the *Records of the Geological Survey of India*.

S. Datta— Born in 1899 Capt. Datta was educated at the Scottish Churches College, Rajsh

College and University College of Science. While studying in M.Sc., classes (chemistry) was awarded Govt. of India State Scholarship for Veterinary Studies in the United Kingdom. He qualified as M.R.C.V.S. from Royal Veterinary College, London in 1925. He came in touch with Sir C. V. Raman, Sir P. C. Ray and Sir John McFadyean. He was appointed Lecturer at the Bengal Veterinary College, and worked with the late Colonel Acton at the Calcutta Tropical School. He was a Veterinary Research Officer at the Imperial Veterinary Research Institute since 1930, holding charge of the Pathology Section for the first seven years and has now been transferred to organise the new Section of Protozoology. While in Bengal service, he advanced the new idea of co-ordinating under one livestock department in India, the four branches of animal husbandry, nutrition, genetics and disea , an idea which is being gradually adopted. His achievements in the field of original researches relate to a group of obscure animal diseases, of which he has worked out the mechanism of causation. His work has already found place in text books and other publications under several heads. He was appointed *rapporteur* for India by Govt. of India at the International Veterinary Congress, Zurich-Interlaken, 1938, and was elected Vice President of the Parasitology Section of the Congress. Capt. Datta represented India at the Imperial Veterinary Conference in London last August and presented scientific papers at the above Congress and Conference. His work on Bovine Haematuria formed an important subject of discussion among the different empire representatives.

S. C. Dhar—Prof. S. C. Dhar was educated in Dacca Pogose School and the Presidency College, Calcutta, where he came in contact with Sir P. C. Ray, Sir J. C. Bose, Prof. C. E. Cullis and several others and were much inspired by them. He passed the M.Sc., Examination in Pure Mathematics in 1916.

He was awarded the Sir Rashbehari Ghose research scholarship in Applied Mathematics and worked as a research student for about a year and half. Here he came in contact with the eminent educationist, Sir Ashutosh Mookerjee and with the inauguration of the new post-graduate department of the Calcutta University he, along with several brilliant young men, was appointed lecturer in Mathematics in 1918. In 1920 he won the Prem Chand Roy Chand studentship in scientific subjects. Prof. Dhar later took up educational work in the College of Science, Nagpur.

At Nagpur Prof. Dhar organised post graduate teaching and research in Mathematics. In 1923 he obtained the degree of D.Sc., of the Calcutta University. In 1934 Dhar undertook journey to Europe to acquaint himself with the latest development of research work in his subject and to acquire experience of the universities of Europe. In 1934 he was awarded the degree of Doctor of Science of the University of Edinburgh which was soon followed by his election as a Fellow of the Royal Society of Edinburgh. Prof. Dhar has guided many students in researc work some of whom have secured Doctor's degree. He has published more than thirty original research papers in various journals in India, Europe and America.

D. Hendry—Born 7th January 1894, Mr. David Hendry is a graduate of Glasgow University where he took the B. Sc. (Agri.) degree in 1920 after an interruption of studies caused by the Great War. In the same year also he took the National Diploma of Agriculture at Leeds University. He went through the War itself in the Royal Artillery, and for the last year held the rank of Major and commanded an 8" battery. After graduation he worked for a few months with the Scottish Board of Agriculture and joined the Indian Agricultural Service in the autumn of 1920.

He went to Burma and was posted to Rangoon in 1921 as Deputy Director of Agriculture, Southern Circle, which in those days comprised the whole of Lower Burma with the rice as the chief crop. He devoted himself to the production and distribution of improved varieties of rice and a number of the best varietes being grown in Burma today are the result of his efforts at the Hmawbi Experimental Station which was under his charge. Experiments on the technique were also carried out at Hmawbi and Mr Hendry published several papers on rice varietal improvement and the manuring of rice in the *Indian Agricultural Journal*. In addition, miscellaneous articles were published in *Tropical Agriculture* and elsewhere.

In 1928 he joined Imperial Chemical Industries (India) Ltd. as a technical adviser, and in 1932 became a director, the experimental work on fertilizers carried out by the company throughout India and Ceylon remaining under his control. In 1937 he was elected to the Bengal Legislative Assembly as a representative of the Bengal Chamber of Commerce and received the Coronation Medal in the same year.

A. C. Joshi— Born at Bahadur Pur, in Punjab, in September 1908, Dr Amar Chand Joshi was educated at D.A.V. High School (now Intermediate College), Hoshiarpur, Forman Christian College, Lahore, and the Punjab University Honours School in Botany, passing the M.Sc. in 1930. In 1936 he submitted his published papers for the D.Sc. degree. He is the first person to receive this degree from the Punjab University since the institution of a lower Ph.D. degree. Sir A. C. Seward and Professor priestley who were his examiners praised his work very much. Sir A. C. Seward, described him as an exceptionally well qualified botanist. After passing his M.Sc. Examination Dr Joshi was appointed a Demonstrator in the Botanical Department of the Punjab University, which he left in October 1931 on being appointed an Assistant Professor in the Benares Hindu University.

While a student at Lahore, Dr Joshi came under the influence of the late Professor S. R. Kashyap and took to the study of plant morphology, though his work is not exactly confined to one field. He has been a keen and enthusiastic research worker ever since he took up his first teaching appointment, and has published a large number of papers on anatomy, floral morphology, embryology and cytology of the angiosperms. He has also completed and revised the *Lahore District Flora* started by the late Professor Kashyap. In the Hindu University he has been able to attract a large number of students and has thus been responsible for the establishment of a school of plant morphology at Benares.

N. K. Sur Born in August, 1892, Dr N. K. Sur passed M.Sc. (Physics) Examination of the Allahabad University from the Muir Central College, Allahabad in 1914. He joined the Ewing Christian College, Allahabad, as a lecturer in physics in July 1914, and was in charge of the department of that college from 1921 to 1926. After serving for some time in the reorganised University of Allahabad he joined the India Meteorological Department as a Meteorologist in October 1927. He has published eighteen papers, either singly or in collaboration with other authors, in physics, in Indian, English and American journals on laminar diffraction, experimental verification of Saha's theory of thermal ionisation, absorption spectra of elements, classification into series of line spectra of elements and a theory of active modification of nitrogen.

In meteorology the ten papers published by him, either singly or in collaboration with others, deal with the thermal structure of the free atmosphere over North-West India, physical characteristics of fronts during the south west monsoon season thermal structure of the upper air over depressions during the south-west monsoon, the thermodynamics of dust storms, thermal characteristics of the free atmosphere over south-west Bengal during the season of nor'westers, and the development of latent instability in different seasons in India.

Book Review

THE NEWER ALCHEMY, *by Lord Rutherford. Cambridge University Press, 1937, pp. 68. Illustrated. Price 3s. 6d.*

It has been mentioned in the preface of this little book that it contains in a somewhat expanded form the subject matter of the Henry Sidgwick Memorial Lecture delivered at Newnham College on November 28, 1936. The title of the book suggests that the original lecture might have been a popular one in which it was described to the audience how in recent times the problem of transmutation of elements, which has so long baffled the attempts of the old school of alchemists, has been attacked successfully by using modern powerful methods. On going through the pages, however, it becomes evident at once that the book contains much more valuable information regarding investigations on artificial disintegration of elements than can be gained from a single popular lecture. Starting with natural radioactivity of elements, the author has first briefly described radioactive transformations, and then the different methods of detecting the particles emitted by radioactive elements have been explained with the help of illustrations. Next, it has been discussed how, while investigating the scattering of α particles by nuclei, the disintegration of the nitrogen nucleus was observed first by the author himself in 1919, and how subsequently it was observed that similar transformations occur in a few more light elements when these are subjected to α-ray bombardment. The discovery and the properties of the neutron are then dealt with in a little more detail and it is explained with the help of illustrations how slow and fast neutrons behave differently in producing transformations in the same element. The discovery of artificial radioactivity and different methods of producing it are next discussed briefly and in the last few pages the artificial methods of transformation are discussed in more detail. Different methods of producing accelerated particles are described and explained briefly with illustrations. A few important examples of transformations produced by different kinds of projectiles are cited and in some cases photographs of cloud chamber tracks are reproduced. There are altogether thirteen beautiful plates with captions and in some cases with explanatory diagrams. This little book written by the great pioneer of transmutation of elements will be of immense use to those who have not specialised in this particular line of research and although eager to gain some useful information regarding the nature of discoveries made in recent years can afford to spend very little time to go through the vast amount of literature. Even to a specialist, the last few pages of the book will be found to be highly interesting.

S. S.

TRENDS OF AGRICULTURE AND POPULATION IN THE GANGES VALLEY: A STUDY IN AGRICULTURAL ECONOMICS, - *by Birendranath Ganguli M.A., Ph.D., Methuen & Co., pp. vi + 314. Price 18s.*

The necessity of the study of agricultural economics cannot be over emphasized in an agricultural country like India. An important aspect of the study of agricultural economics should not only be intensive in its character but also proceed on a regional basis. Dr Birendranath Ganguli in his recently published work, has attempted an intensive study of the trends of agriculture and population in the Ganges Valley and his work in an welcome addition to the growing volume of studies in agricultural economics of India on a regional basis. The writer of this book has divided the whole Ganges

Valley into three parts: (1) the Upper Ganges Valley, stretching from the northernmost border of U.P. to Chapra, (2) the Middle Ganges Valley, covering practically the Bihar area and (3) the Ganges Delta including in it the Lower Bengal and the Dacca Division. He has further examined the trends of agriculture and population in each of these divisions in the light of extension of cultivation and density, double-cropping and density, agricultural water-supply and density and crops and density. The general conclusions are that in the Upper Ganges Valley, cultivation has been practically fully extended, while "extensive double cropping in this region signifies a more widespread tendency to resort to more intensive subsistence farming which has been forced upon the cultivators by the growth of population........and it is very likely that the recent decrease in the double cropped area is a symptom of over-population producing its dangerous reactions on the stability of rural economy." The Middle Ganges Valley however is divided, says the writer, by the river Ganges into two portions with distinct physical characteristics and while the northern portion is extremely over-populated, the southern portion reached its population limit by the closing years of the last century and since then the pressure has been relieved by emigration. Lastly, with regard to the Ganges Delta which is a natural region supporting a phenomenally high density of population, the writer remarks, that the density of population has a tendency to increase at a higher rate in the fertile and healthy tracts of the active delta than in the decadent regions of the moribund delta, *e.g., Rarh*, where both agricultural productivity and public health are at a low level.

The study suffers from the absence of any constructive conclusion based on the socio-economic trends discovered to be in operation; but that possibly was not the object of the author. The book, we hope, will find appreciation from those who are interested in the agricultural economics of our country. A bibliography would have enhanced the value of the book all the more, while a more intensive statement of sources from which figures have been drawn and authorities quoted would have much helped other students of agricultural economy. We hope, these points will receive attention from the author in the next edition.

B. C. S.

AN INTRODUCTION TO COMPARATIVE BIOCHEMISTRY,—*by E. Baldwin, with a forward by Prof. Sir Frederick Gowland Hopkins. Cambridge University Press, pp. 112 including a bibliography and an index. Price 5s.*

This handy book, though mainly written for the undergraduates, is yet capable to cater for a much wider public. Even among the research workers in biochemistry, a perusal of this book is sure to provoke new ideas. The physico chemical processes associated with the manifestation of life have been sorted out into several groups, such as regulation of osmotic pressure, respiration, nitrogen and purine metabolisms etc. In clear and simple language, the author has described the chemical differences existing in various species. Wherever possible he has also tried to point out how the differentiations, the capacity of elaborating mechanisms suitable to adopt themselves to new environment, have helped these animals in their struggle for existence. The data presented in the various chapters of the book may tempt workers in various branches of biochemistry to extend their observations on one particular species to different groups of animals. Such activities not only help to develop the science of biochemistry on the widest possible scale but may ultimately furnish a key to the least understood parts of evolution.

S. N. R.

PALAEMON: THE INDIAN RIVER PRAWN, (*The Indian Zoological Memoirs on Indian Animal Types, edited by Professor K. N. Bahl No. 6*)- *by Dr S. S. Patwardhan. Lucknow Publishing House. 1937; pp. 100, with 65 text figures. Price Rs. 2/-.*

This zoological memoir is a useful addition to the well-known series of memoirs edited by K. N. Bahl which is proving of great utility in the study and teaching of zoology in India and probably in other countries as well. The fresh water prawn is dissected as the type of the Crustacea in almost all the Indian universities in place of the crayfish *Astacus*, which is found in Europe and is described in English text-books that have so far been in use

for the study of zoology in this country. The prawn presents such remarkable differences from the crayfish in its anatomy, that a memoir on the subject was urgently called for.

The external characters and the skeleton are fully described and illustrated. Figures of hand-cut transverse sections of the abdomen and thorax give to an elementary student a proper idea of the disposition of muscles and organs within the frame work of the exoskeleton. The figures of the appendages of the various segments are also so arranged on p. 15 as to make this part of the subject easily intelligible, and a glance at the figures should make the practical work of the student easy. The structural modifications of the appendages for the particular functions are rightly emphasised.

The chapter on the respiratory system gives an account of the various kinds of gills situated in the large but compressed gill-chambers, one on each side of the thorax; the number and position of the gills is summarised in the form of a branchial formula; and the course of the circulation of water in the gill-chamber is adequately described. The structure of the cardiac stomach with its valves and plate as shown in figs. 35 and 36 is interesting. The gastric mill characteristic of many Decapoda like crayfish, crabs and lobsters is absent in the prawn, in which the molar processes of the two mandibles pressing against each other in the buccal cavity act as a food-crushing apparatus. But the moving combs of the plates probably reduce the food particles to a very fine state of division. The valves which are fringed with setae are so arranged that only dissolved food or food in a very finely divided state can pass through the X shaped cardio-pyloric aperture into the pyloric chamber, which consists of a dorsal and a ventral chamber and contains the filter-plate. Regurgitation of food from the mid-gut back into the pyloric stomach is prevented by the groups of setae of the dorsal chamber, which all project backwards into the mid-gut.

The digestive mechanism of the pyloric stomach is also satisfactorily described. The food first enters posteriorly into the ventral chamber in a liquid state or in the form of very fine particles, where it passes through the filtering apparatus, and the filterate passes backwards into the hepato-pancreatic ducts, while the refuse over the filter consisting of larger particles of undigested or indigestible food is pushed upwards into the dorsal chamber, whence it is forced back into the mid gut. The hepato-pancreas or the so-called 'liver' is a large massive organ composed of numerous glandular tubules branching in a racemose manner, the branches being held together in a compact mass by the intervening connective tissue. Though the physiology of the hepato pancreas of *Palaemon* has not yet been worked out, the author quotes the account of its physiology in the Norway lobster *Nephrops norvegicus* as described by Yonge. The hepato-pancreas not only secretes digestive ferments but also absorbs digested food material and thus performs the functions of the pancreas, liver and small intestine of higher animals.

The account of the blood-vascular system gives the necessary details and the course of circulation of blood is well described and diagrammatically represented. The kidney of the adult prawn which are a pair of antennary glands, are also described in detail. The end-sac secretes ammoniacal compounds while uric acid and other nitrogenous waste products allied to urea have been detected in other parts of the excretory organs. The integument is also believed to be an important organ of excretion. The thick chitinous layer, a non living nitrogenous product secreted by the integument, is cast off at each moult and is believed to be a special device for getting rid of the waste products of metabolism. The chapters on the nervous system and receptor organs leave nothing to be desired.

We wish the series every success, which it richly deserves and hope that the succeeding numbers will follow soon.

H. R. M.

THE THEORY AND CONSTRUCTION OF NON DIFFERENTIABLE FUNCTION: (*Lucknow University Studies No. 1*), *by A. N. Singh, D.Sc., The University of Lucknow, pp. 110. Price not stated.*

This booklet publishes the summary of a course of four lectures delivered by the author under the auspices of the Faculty of Science of the Lucknow

University during the session 1934-35. There exists at present no treatise at least in English in which a systematic and general account of the theory and construction of non differentiable functions is given, and an attempt has been made herein to give "as comprehensive an account of development relating to non differentiable functions as is possible within a limited scope of a hundred pages. Necessary proofs of the theorems have been given in some cases." The first lecture deals with the history of the attempts to construct non-differentiable functions by the nineteenth century mathematics, the second and the third lectures contain respectively the geometrically and arithmetically defined non differentiable functions while the fourth lecture is devoted to the discussion of the properties of the functions.

In some cases examples and allied theorems have been discussed. The value of the book has been enhanced by the inclusion of an exhaustive and uptodate bibliography on the subject.

M. S. C.

PARASITIC WORMS AND DISEASE. *(Lucknow University Studies No. III) by Gobind Singh Thapar, M.Sc., Ph.D. (Lond). The University of Lucknow. pp. iii + 46. Price not stated.*

It is indeed time, as the author observed, that helminthology should no longer be a neglected subject in India. The author has taken a plea in this small book for furthering intensive works in this branch of science which would solve some economic problems of India. He is, therefore, fully justified in evoking an interest in the popular mind.

The book is divided into three chapters which are in the form of lectures illustrated with lantern slides, and it would have been better appreciated had it contained a few illustrations.

The book can be recommended as a small treatise of an interesting branch of biology, which deserves to become popular, and provide a suitable guide to a beginner in helminthological studies.

H. M.

THREE LECTURES ON PHOTOCHEMICAL PROCESSES. *(Lucknow University Studies No. IV)—by P. S. MacMahon. The University of Lucknow, pp. 68. Price not stated.*

The booklet under review forms the fourth number of the series, *Lucknow University Studies* edited by Prof. B. Sahni, F.R.S., Dean of the Faculty of Science, Lucknow University. These lectures were delivered under the auspices of the Faculty of Science of the University for the benefit of the advanced students.

After giving a clear and concise account of the fundamental physical theories affecting photochemistry, *e.g.*, the quantum theory, the Bohr atom, molecular spectra and the Einstein law of photochemical equvalents, the author has dealt with the mechanism of photochemical reactions. This is followed by a discussion of the hydrogen-chlorine reaction kinetics and a special treatment of all the theories dealing with their reaction mechanism. The author himself has contributed conspicuously to the earlier development of this particular subject

This booklet will undoubtedly prove very useful to the advanced students interested in photo chemistry, though it would be rather difficult for many to go through the last two chapters without consulting the original papers referred to, a complete list of which is appended at the close.

P. R.

SALTATION IN FUNGI. *(Lucknow University Studies No. V)—by Dr S. N. Das Gupta. The University of Lucknow, pp. 83. Price not stated.*

This booklet with a bibliography covering seventeen pages is based on a course of three lectures on saltation and related phenomena in fungi delivered by Dr Das Gupta at the University of Lucknow during the session 1934-1935. It has been published under the editorial supervision of Prof. B. Sahni F. R. S. the Dean of the Faculty of Science of the Lucknow University who is mainly responsible for the initiation of such highly useful intellectual activity amongst the University staff.

The term 'saltation in fungi' corresponds to mutation in higher plants which is defined as a sudden and spontaneous production of new forms from old stocks. Muller suggested that the use of the term

'mutation' should be confined to cases where a real change in the gene is involved. But the true nature of variations in fungi is unknown. Such variations may mean definite change in the genotypic character of the fungi, *i.e.*, change in the nuclear apparatus, or it may mean simple segregation from a heterozygous parent. Dr Das Gupta has ably discussed this point at length and has pointed out that many of the saltations recorded in mycological literature are mere segregations from a hybrid strain. He has referred to the interesting work of Burgeff in *Phycomyces nitens* who by micro-operation produced new strain by effecting heterocaryosis under experimental conditions, to the work of Hansen and Smith who claim to have produced new strains of *Botrytis* by growing two different strains of the same fungus together in a synthetic medium, to the experimental work by means of a micro manipulator of Richard Harder who produced a haploid strain of *Pholiota mutabilis* from a diploid strain, and to the work of the author himself (Dr Das Gupta) who demonstrated that contiguous portions of a small hyphae of *Diaporthe perniciosa* DHe may contain different characters.

The author has devoted a chapter to a discussion of various types of saltation found in fungi, finally ending with cases of reversion. Though in some cases (*viz.*, *Fusarium* recorded by Brown) the saltants remain usually stable, instances of true saltation (mutation) are not many in fungi. In good many cases the nutritive conditions of the culture medium play a prominent part in inducing saltation. Passing to a review of examples of induced saltation Dr Das Gupta has cited cases of saltation amongst the lower fungi induced by chemicals, H' ion concentration, oxidation, wounding, temperature, light, ultraviolet radiation, X radiation and radium-radiation where the external factors play a role either in the production of saltants or in the differentiation of the saltant from the parent after the former has been produced. But in my experience with cultures of hard fungi (*Polypores*) I could not find any evidence of saltation or mutation by treatment with chemicals or under the influence of temperature, light and artificial radiation (*i.e.*, ultraviolet, X-rays and radium): they seemed absolutely stable, not alterable by any change of circumstances or conditions. In this connection several investigators have found that different species as well as different individuals of the same species vary in their reaction to the rays, only those plants whose genes are in unbalanced state can be easily changed by the action of X rays, ultraviolet and radium.

Finally, the author has ranged the variations between parent and saltants under three classes *viz.*, (1) morphological (specific difference and generic difference), (2) physiological and (3) with reference to parasitic activity. The origin of a more virulent strain from a comparatively harmless one is fraught with possibilities: it may have some significant relation to the sudden appearance of a disease in an epidemic form. Dr Chaudhuri compares saltation in fungi to bud-variation and plant chimeras in high plants, in both only the somatic cells are involved in the genetical change.

The lectures are, on the whole, very stimulating to students of fungi and contain a mass of well-arranged data relating to various aspects of saltation in fungi.

S. R. B.

LIESEGANG RINGS AND THE INFLUENCE OF MEDIA ON THEIR FORMATION. (*Lucknow University Studies No. VII*)—*by A. C. Chatterjee, D.Sc., The University of Lucknow, pp. 29 including a bibliography, Price not stated.*

In this monograph the author has discussed the various conditions under which Liesegang rings are formed in a number of gels and has reviewed critically the various theories put forward to account for this phenomenon. The few cases on record in which Liesegang rings are formed even in the absence of any gel, have apparently escaped the notice of the author, as no mention of these is found in the monograph.

B. N. G.

THE GENERAL FIELD THEORY OF SCHOUTEN AND VAN DANTZIG. (*Lucknow University Studies No. 10*)—*by N. G. Shabde, D.Sc., The University of Lucknow, pp. 55 including a bibliography. Price not stated.*

This monograph contains three lectures given at Lucknow by Prof. N. G. Shabde of the University

of Nagpur. The recent attempts by Schouten and Van Dantzig at the construction of a unified field theory embracing gravitation and electro-magnetism in one composite system involve the use of five co-ordinates instead of the usual four, and belong to that scheme of geometrization of natural laws which is known as Projective Relativity. This idea originally started by Einstein and Mayer has received remarkable generalization in the works of Schouten and Van Dantzig. Prof. Shabde has very ably presented their theories within a very short compass in the first two lectures, while the third lecture is mainly devoted to the mathematical working of identities inherent in the projective theory -this last part representing Dr Shabde's own work on the subject. The bibliography at the end of the monograph will prove very valuable to those who want to follow up the subject.

N. R. S.

The Age of Indian Mountains

The age of the *Deccan Traps* has been a much-discussed problem during these last few years. These enormous masses of basaltic lava flows extended over 250,000 square miles from Bombay all through the Indian peninsula in an average thickness of several thousand feet. Their age is hard to determine because they are in the main of terrestrial origin, whereas our geologic chronology has been primarily based upon the succession and fossil contents of rocks that have been formed in the sea. Only in one place, at Rajahmundry near the Bay of Bengal, are marine beds intercalated between the terrestrial strata, thus giving a clue into which of the known geological formations the latter should be ranged.

The theory that the Daccan Traps are of Cretaceous origin has been shaken recently by two young native geologists, of the University of Mysore, S. R. Narayana Rao and K. Sripada Rao, who found between the lava layers remainders of land plants and fishes and fresh-water algae which seemed to belong to the Old Tertiary period. Moreover in the Rajahmundry limestone they discovered marine shells not yet studied in this light and also specimens of a family of marine algae about which a great many papers have been prepared in the Vienna Museum of Natural History. These are known, by Prof. Julius of Pia, as " whorl algae." They sent their material to Vienna, Professor Pia examined it and ascertained that it contained no forms exclusively known from the Cretaceous, but several characteristic for the Old Tertiary period.

—Discovery

LETTERS TO THE EDITOR

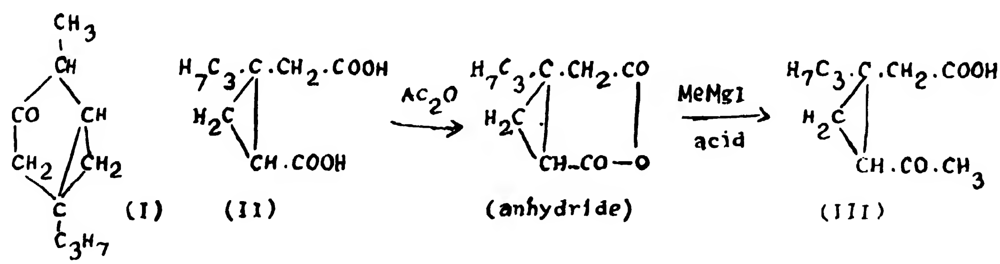
[The Editor is not responsible for the views expressed in the Letters.]

Researches on total synthesis of Thujone.

The compounds of the thujane group do not occur very widely in nature. Two hydrocarbons, α thujene and sabinene; two alcohols, sabinol and thujyl alcohol; and two ketones, thujone and umbellulone; are the only compounds known to occur in nature.

Synthetical experiments in the thujane series are too meagre as compared with the vast amount of work done in the other branches of bicyclic terpenes. The difficulties involved in a successful synthesis of the thujane skeleton lie, not in an inconsiderable extent, in the ease with which the *cyclopropane* ring breaks to give either six or five-membered cyclic compounds, depending upon how the ring opens up.[1]

Ruzicka and Koolhaas[2] effected the partial synthesis of thujone starting from thujaketonic acid, a direct degradation product of thujone. It was planned to effect a total synthesis to thujone (I) starting from umbellularic acid *via*, thujadicarboxylic acid (II) and thujaketonic acid (III). Thujadicarboxylic acid (m.p., 145-46°), prepared from thujone has been successfully converted into thujaketonic acid as follows:



(I) (II) (anhydride) (III)

The m.p.'s of the synthetic thujaketonic acid (Found: C, 64.99; H, 8.73. $C_{10}H_{16}O_3$ requires C, 65.22; H, 8.70 per cent.), and its semicarbazone (Found: N, 17.12. $C_{11}H_{19}O_3N_3$ requires N, 17.43 per cent.), are 74-75° and 184-85° respectively, remaining undepressed when taken mixed with genuine samples.

The conversion of thujadicarboxylic acid into thujaketonic acid, having been achieved, the total synthesis of thujone lies in the conversion of umbellularic acid already synthesised, into thujadicarboxylic acid. The following scheme of research is being worked out to achieve this end.

$$\text{Umbellularic acid} \xrightarrow{Ac_2O} \text{anhydride} \xrightarrow{NaOEt} \text{monoester mono-acid}$$

$$\xrightarrow{SOCl_2} \text{monoester mono acid chloride} \xrightarrow{CH_2N_2} \text{monoester diazoketone} \xrightarrow[\text{alc.}]{Ag} \text{monoester of thuja dicarboxylic acid}$$

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P. C. Guha.
M. S. Muthanna.

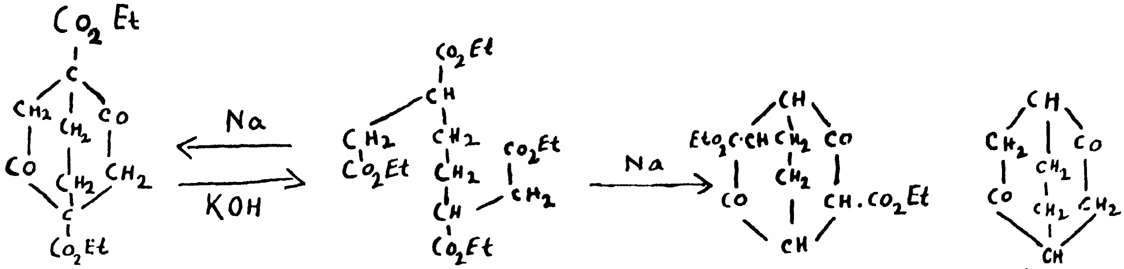
[1] *Cf.* Guha's Presidential address, Chemistry Section, *Proc. Indian Sci. Cong.*, 1936, p. 148.

[2] *Helv. Chim. Acta.*, 15, 944, 1932.

Synthesis of Bicyclo-[2:2:2]-octane-1:4-dione.

$\beta\beta'$ Dicarboxy-suberic acid corresponding to ester (I) was obtained for the first time from the bicyclo [2:2:2]-octane derivative (II) by ring fission with the aid of potassium hydroxide[1] and as the yield of the acid obtained by this degradative process was rather poor, it was synthesised later[2] starting from ethyl butane-tetra-carboxylate and bromacetic ester. It seemed of interest to try the synthesis of the bicyclic compound (II) by effecting a double Dieckmann condensation with the ester (I), which has accordingly been subjected to the action of molecular sodium in benzene medium. Of the two possible ways in which double Dieckmann condensation can take place, giving rise to compounds (II) and (III) respectively, it has been found that the reaction actually takes the course by which compound (III) is only formed. On

hydrolysis and decarboxylation compound (III) readily gives a neutral diketone (m.p., 205-6°) whose structure has been established to be bicyclo [2:2:2] octane 1:4-dione from its


(II) (I) (III) (IV)

combustion values, by preparing a disemicarbazone, m.p., 244-45°, and from its molecular weight. It is to be observed that on hydrolysis and decarboxylation both the compounds (II) and (III) should give the identical diketone (IV). But in view of the observation made in a previous note[3] that compound (II) is very resistant to decarboxylation, a fact which is in agreement with a similar observation of Bredt[4] the double Dieckmann condensation must have proceeded to yield compound (III). Work on the conversion of the diketone (IV) into the corresponding hydrocarbon bicyclo [2:2:2]-octane, is in progress.

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P. C. Guha.
C. Krishnamurthy

[1] Guha, *Current Science*, 5, 19, 1936.
[2] Guha and Krishnamurthy, *Current Science*, 6, 503, 1936.
[3] Guha, *loc. cit.*
[4] *J. Pr. Chem.*, II, *148*, 221, 1937.

SCIENCE AND CULTURE

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Bengal Fisheries: Their Past, Present and Future

Fish as the Food of the People

THE detailed and careful enquiries of Sir K. G. Gupta (1906-08), who was placed on special duty by the Government of Bengal to investigate the fishery conditions in the province, brought out the fact that no less than 80 per cent of the population of Bengal eat fish. He further found that whilst most people do not eat fish every day, and though at certain times of the year fish is taboo for at least the higher classes of the Hindus, it may safely be estimated that for at least 320 days of the year fish forms a very important part of the diet of the fish-eating people in the province. Allowing about 2 chattaks or 4 oz. per head per day, he estimated the quantity consumed per head to be one maund a year. Mr. K. C. De, who similarly carried out detailed enquiries into the fisheries of Eastern Bengal and Assam (1908-10), however, estimated the amount of fish consumed to be at least 1½ maunds per head per annum, or about one and a half times of the quantity consumed in Western Bengal. The population of Bengal at the last Census was estimated at a little over 50 millions and, therefore, for the consumption of the fish-eating population of the province, an annual supply of 40-60 million maunds of fish is necessary. In Bengal meat, milk and butter are only sparsely used as articles of food, their use being confined to the more wealthy classes. The staple grain diet consists of boiled rice which is deficient in nitrogen, phosphorus and animal fat, all of which are essential elements for a normal diet, and for this reason the importance of fish for providing the necessary elements in the daily diet of the poor cannot be overstressed. In spite of these, questions of conservation and improvement of fisheries in Bengal have been entirely ignored both by the authorities concerned and the general public. As a result the fisheries in the province instead of contributing to its prosperity, as they do in other countries, supplying the necessary food for the majority of its population, and furnishing employment and occupation for the large hordes of its unemployed, are deteriorating from year to year. The condition of the large-fishermen-class also is simply deplorable, this is certainly due to the

unfortunate circumstances that have developed as a result of the extraordinary grip of an all powerful ring of middlemen over the marketing and sale of fish. As a result the poor fishermen do not realize even bare living wages for their very arduous labours, while the consumers have to pay very exorbitant and impossible price for the fish sold in the retail markets.

Fisheries in Bengal

For the supply of the enormous quantities of fish required for its large population, Bengal is mainly dependent on its inland fisheries. It is somewhat difficult to estimate accurately the extent of these fisheries consisting of fresh-water fisheries in rivers, tanks, *bhils* and other fresh-water areas and the estuarine fisheries in the Gangetic Delta, but Mr T. Southwell, who was connected with the Department of Fisheries of Bengal, Bihar and Orissa, from 1911 to 1918, estimated the potential fishery area in Bengal at somewhere between 7-8000 square miles in the dry season. During the rains, however, when a much greater part of the country is under water, the fisheries also temporarily become more extensive. In spite of this, the fish supply in the province, as various authorities have pointed out, is inadequate, and the prices ruling for the available fish are so high that it is impossible for the poorer and, in some cases, even the middle classes to purchase the necessary quantity. Taking Calcutta as an example, for which some statistics for the imports both along rivers and canals and the railways are available, it is found that the supply of fish available per annum per head of the population works out at not more than 10 seers, which is about 1/4th to 1/6th of the normal requirements for an adult. The amount of fish available in Calcutta has decreased since these statistics were compiled. With the increased facilities for transport more and more fish is now re-exported from Calcutta and as a result comparatively much smaller quantity at much higher prices is left for local consumption.

Neglected Marine Fisheries of the Bay of Bengal

The dependence of Bengal for its fish supply on its inland fisheries is due, in the main, to the very rich and easily accessible source of supply. The marine fisheries in the Bay of Bengal is almost entirely neglected; except for a little foreshore fishing practically no fishing is carried out anywhere in this extensive area. It has been opined that the reason for the non-development of the marine fisheries lies in the inherent prejudice on the part of the fish-eating population of Bengal to sea-fish of any kind. This is probably due to the fish eating population of Bengal never having had a chance of getting accustomed to sea-fish, though it has also been suggested that the Bengal public have a special preference for fresh-water fishes with a muddy taste and do not like the salty sea fish. In addition, marine fishing requires a fair amount of capital and a great deal of organization, as except for the limited foreshore fishing, marine fishing is not possible by individual fishermen with their indigenous, small country boats and primitive nets. The pioneer work for exploring and assessing the possibilities of marine fisheries in the Bay of Bengal was carried out by Lt Col. A. W. Alcock, the Surgeon Naturalist on board the R.I.M.S.S. *Investigator*. For a number of years the Fisheries Department of the Government of Bengal carried out experimental trawling in the Bay of Bengal with the steam-trawler *Golden Crown* to determine whether trawling in the area was at all practicable, and, if so, to locate and chart the principal fishing grounds. In addition, a survey was carried out of the various kinds of fish available, as also of their quantities and the seasons when they are most abundant. Though as a result of all this work the very rich nature of the fisheries, as suggested by Alcock, was fully borne out, the exploitation of these fisheries on sound commercial lines has not so far been attempted by any agency.

Causes of the Depletion of Inland Fisheries

The popular cry that the fresh-water fisheries of Bengal have greatly deteriorated and are getting impoverished from year to year has been responsible for various official enquiries into their condition carried out since the middle of the last century (*vide infra*), but unfortunately no permanent measures of any value have been adopted for their improvement. Both natural and human agencies are responsible for the impoverishment of the fisheries. Among the natural agencies, the chief is the gradu

decrease of the area under water. This is the result of various natural agencies concerned with the levelling of the earth's surface. The rivers in the alluvial plains of Bengal bring down an enormous quantity of silt from the upper regions. This silt is held in suspension in the water, and is gradually deposited over inundated tracts or wherever the current becomes arrested. The land level is consequently rising even though imperceptibly, from year to year and depressions are gradually being filled up. This is all the more apparent in the swamps of the *bhil* areas, such as those in Faridpore, Bakkergunge, Mymensingh and the mundane areas of Tipperah, etc. Similar causes operate in the gradual silting up of smaller water channels. Earthquakes within recent times have quickened this natural process by raising the beds of rivers and *bhils* in various parts of Bengal. These causes are beyond human control, but natural processes are also hastened by the human agency. As a result of various canals and irrigation schemes in Northern India the volume of water flowing down the Ganges and its tributaries has greatly decreased. The diversion of very large amounts of water from the main channels in the upper reaches of the Ganges system has greatly reduced the force of the current in the lower reaches in Bengal and this when confronted by the greater force of the tides greatly hastens the rate of deposition of the alluvial silt held in suspension. Reclamation of land in the Gangetic Delta, putting up of *bunds* and other artificial restrictions in the courses of the streams is also responsible for the silting up of their channels at a more rapid rate. Further the sluggishness of the current often results in a luxurious growth of water plants and aquatic weeds in them. This accumulation accelerates the deposition of silt by further reducing the force of the current, while the large quantities of detritus deposited as a result of the decomposed weeds also make the stream shallower. The stoppage of the free flow of water across country areas by embakments of roads and railways tracks is similarly responsible for the drying up of many *bhils* and other inland fishery areas. Finally, the deterioration of the fresh-water fisheries has resulted from the waters in the lower reaches of the rivers becoming more and more saline.

In connection with the deterioration of the waterways of Bengal mention may also be made of effects of pollution due to the erection of factories of all descriptions along river banks, retting of jute in streams, etc., and above all the disposal of sewage and filth in the main or smaller rivers. All these factors and particularly pollution due to human agency in the neighbourhood of larger towns are responsible for the deterioration of numerous very-flourishing fisheries. Finally, increasing river traffic, particularly along steamer routes, not only affects the fisheries directly but as a result of the pollution of the water is responsible for their deterioration.

Among the direct effects of human influence reference may be made to the results of intensive fishing carried on all over the province since times immemorial. An important factor is the catching of fish during breeding season when they congregate in large shoals, and are easily caught in larger numbers. As a direct result the brood fish decrease greatly in number, and with corresponding fall in the numbers of eggs and young ones the chances for the depleted fisheries being repopulated are greatly reduced. Whereas by moderate and judicious fishing, fisheries could be normally maintained and even improved, the greed of immediate gain results in the fishermen depleting really flourishing fisheries by intensive fishing. There is no doubt that there is no overfishing in the estuaries or the bigger rivers, but the absence of any close seasons or of protection for the breeding fish at any time of the year is certainly responsible for the great reduction in the numbers of fish. Reference in this connection has to be made to the short term leases of fisheries and the peculiar conditions prevailing throughout as a result of Permanent Settlement and vested rights in reference to the rights of fishing. In almost all cases, fisheries are leased from year to year and the lessee in order to make the most profit from fishing during the period of his lease does not hesitate to capture every fish in the area, whether mature or immature. Finally, but for the natural agency no attempt whatsoever is made to restock or repopulate the main fisheries. Only in the case of the tanks, a primitive type of fish culture is carried out, but the results are of very little value either in increasing the yield or for improving the condition of the fisheries even in these fisheries of minor importance.

Main Types of Fishes Found in Bengal

Bengal is very rich in the varieties of fish that inhabit its waters, but unfortunately no separate comprehensive accounts of these are so far available. Over 1600 species of fish have been recorded from India and some 250 of them are probably found in Bengal. A great majority of these, however, are of very little economic importance. The fishes which are particularly favoured by the Bengalees are the fresh-water carps, the chief among which are the *Catla*, *Rohu*, *Mrigal* and *Calbaus*, the Indian Shad or *Hilsa* and the *Topsi*. In addition some small-scaled fishes like the *Koi*, snake-headed fishes like *Saul* or *Sauli* and the scaleless siluroids like *Magur*, *Singhi*, and a few other forms which are generally included under that comprehensive name " Jeol Machh " or the fish that can be transported alive and sold as such to the consumers, and the larger species like *Boal*, *Pabda*, etc., from the majority of the edible fishes of Bengal. In addition *Bhetki*, which is essentially a marine form, but which also flourishes in the estuaries and, to some extent, in fresh waters, is greatly in demand with the Europeans and some classes of the Indians.

Lack of Information about Fish and Fisheries

Unfortunately very little information is available either regarding the exact distribution of the different species of fish, their breeding seasons, rates of growth, their diseases and various factors connected with their life-history. The defunct Bengal Fisheries Department carried out investigations on all these points, but its small and poorly trained staff was far from sufficient for the collection of necessary data. Further in the absence of any experimental fish farms and stations, which are the *sine qua non* for such work and which the Fisheries Department had not, there was no chance of any progress being made in connection with such enquiries.

Fishery Investigations

Investigations on fish and fisheries of Bengal started fairly early. Dr Buchanan Hamilton, a member of the Bengal Medical Service, made a special study of the fishes of the Ganges, beginning from 1784, and published his results in a volume entitled the *Fishes of the Ganges* (1822). He also carried out investigations on the fisheries of various districts of Bengal, which were later incorporated in Hunter's *Gazetteer*. In 1867 at the instance of Mr Grote, senior member of the Board of Revenue, and Col. Strachey, Inspector-General of Irrigation Works, fishery enquiries were initiated, and a very useful questionnaire regarding the fish and fisheries of Bengal was issued; this was so comprehensive that it can still be regarded as the essential basis for the future programme of any fishery investigations in the province. In the same year the attention of the Government of Madras was directed to the great harm being done to the coastal fisheries by the irrigation works at the mouths of the rivers, and in 1868 Surgeon-Major Francis Day was deputed to enquire into the subject. Subsequently he was appointed Inspector-General of Fisheries for the whole of India and he submitted a complete report of the fresh water and sea fisheries of the Indian Empire, which was published in 1873. Day also published a voluminous work entitled *Fishes of India* (1876-78), with illustrations of all known species, and this work in an abridged form was published in two volume in the *Fauna of British India* series in 1889. Lt-Col. A. Alcock, I.M.S., made extensive enquiries into the coastal and estuarine fisheries in the Bay of Bengal during his tenure as Surgeon-Naturalist to the Marine Survey of India and later as the Superintendent of the Indian Museum in the nineties of the last century, and concluded that the fisheries of the Bay of Bengal " are of inestimable value, and whoever has enterprise enough to take them up and strength of purpose and length of means to stick to them, will reap a manifold return." In 1906 the Government of Bengal placed Sir K. G. Gupta on special duty to enquire into the Bengal fisheries and as a result of one of his principal recommendations a Fishery Board for Bengal with Mr A. Ahmad as Commissioner of Fisheries was constituted in 1909. With a view to a detailed survey of the marine fisheries in the Bay of Bengal a steam trawler *Golden Crown* was purchased and Dr J. T. Jenkins of the Lancashire Sea Fisheries was appointed to direct the work. Dr Jenkins also made a preliminary survey of the estuarine fisheries in the Gangetic Delta, and concluded that the fisheries offered a profitable return on any capital that may be invested on a properly organized scheme. In 191

the Fishery Department was amalgamated with the Department of Agriculture and the Director of Agriculture also became the Director of Fisheries. *Inter alia* it may be mentioned that the department was a joint one for the provinces of Bengal, Bihar and Orissa. In 1911 Mr T. Southwell was appointed Deputy Director of the Fisheries. In 1917 the Fishery Department was again separated from the Agriculture Department with Mr Southwell as its Director. In 1918 Mr Southwell left the Department and Dr B. Prashad carried on as Director of Fisheries till his transfer to the Zoological Survey of India in April 1920. After this date the Department was again placed under the charge of the Director of Agriculture and was finally abolished as a measure of retrenchment in 1923. In 1925 Mr R. S. Finlow, Director of Agriculture, Bengal, while on leave ex-India, was deputed to Central Europe to study the conditions governing the successful, artificial culture of European carp. In 1929 he visited the various centres of the Madras Fisheries Department to study the progress in reference to fisheries made in the province. As a result of these enquiries he submitted a scheme for the reorganization of a Fisheries Department in Bengal in 1932, in which he briefly reviewed the earlier work and gave weighty reasons for the reorganization of a Fisheries Department for the province and outlined the main lines of work. No action seems to have been taken on his recommendations, but in November 1937 an officer of the Madras Fisheries Department was placed on special duty for a year to survey the conditions and make recommendations for the organization of fisheries work in the province.

We hope to suggest in the next issue a programme for immediate working by the Department of Fisheries whose revival is urgently called for because of the present neglected and deplorable state of the fish-growing areas. During recent years we have seen a rapid rise and growth of several industries in the country, and even agriculture has been receiving considerably more attention than hithertofore. With fisheries, however, the case as has been detailed in this article, is entirely different. The natural rich heritage in regard to fisheries in the province is being constantly reduced through wastage, wilful or otherwise. Agriculture and Irrigation and the Department of Industries too have been allowed to develop at the expense of fisheries. Unfortunately, surprise is still expressed in certain quarters that the improvement of fisheries can have a very great economic bearing on the welfare of the people. All authorities, who have paid any attention to the subject, are however unanimous that efficient research and organization are the only solutions of the problem. Even though the available resources of the province may not be able to afford a highly organized fisheries department such as that of most European countries and the United States of America, the importance of the problem demands that as well equipped and properly staffed a department as possible should without the least delay be organized for the improvement of the fisheries and for bettering the lot of the poor fishermen of the province. If organized on proper lines and supplied with the necessary resources in the way of funds and facilities for work, there can be no doubt that the department should besides improving the conditions of the fisheries in the province and providing the much needed food for the majority of its population, be able to reduce unemployment by providing work in various directions.

Some Aspects of Vernalization*

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In recent years, no advance in agricultural science has been so widely appreciated as the process of vernalization. Pre-sowing treatment of the seed in order to reduce the growth period of cereals and other crop plants has become known as vernalization all over the world. The main principle of vernalization was first presented in 1929 by T. D. Lysenko in Russia; thereafter the agronomists have explored the possibility of applying it to crop production. The results so far available are encouraging, although failures also have been recorded by workers in different countries. The practical utility of the process is great and in Russia the process has been widely used in order to grow crops in regions where both light and temperature conditions are inadequate for the maturation of grain crops. Far in the north, upto a few years ago, agriculture was confined to growing some corn during a brief vegetative season because for ten months in the year the soil was icebound. Varieties of high yielding wheat, good strains of potato free from disease, and other vegetables and fodders were difficult to cultivate and the little cultivation possible was not very profitable on account of the failure of such cereals to ripen. The technique of vernalization is found to be of immense importance in extending agriculture to the arctic region. Varieties of wheat and barley from Odessa in the south of Russia, having very different climatic and geographical conditions from those of the Polar region, succeeded in ripening in these extremely cold places, where without vernalization they failed to bear flowers. Completion of the life cycle of the plant within a remarkably short period is of great economic importance; the process of vernalization has hastened the production of flowers and fruiting in a large number of cereals all over the world. Where the geneticist failed to breed good varieties adapted to local conditions, this Russian technique based on the physiological principles of plant development has succeeded in overcoming the difficulty. Suffice it to say that in Odessa a new spring variety of wheat has been produced by Lysenko in 2½ years, which would have required 15 years by selection work.

Theoretical considerations. According to Lysenko, the development of cereals towards seed formation consists of certain stages and these stages are traversed by the plant in strict sequence before it begins to mature. Without the completion of one stage, a plant cannot pass on to the succeeding stage. In cases where conditions are suitable for all stages except one, it has been found that plants proceed up to that stage of development for which conditions are favourable and then cease further development notwithstanding the availability of favourable conditions for the later stages. Each of these stages requires for its completion a definite set of external conditions such as temperature, light, humidity and aeration.

Thermo-stage—In the case of temperate cereals the first of these stages depends upon low temperature, ranging from 0° to 20°C according to variety, and combined with suitable conditions of moisture and proper aeration. Time necessary for the completion of this stage varies with environmental conditions. Lysenko opines that no progress towards flower development is possible unless this stage, known as the thermo-stage, is complete. Flower initials are laid down in the plant when this stage is completely traversed by it. It is remarkable that the thermo-stage of development is not only effective in growing plants, but also in seeds when the dormant embryos are aroused to activity. The embryo remaining inside the seed can successfully pass this stage of low temperature and later when conditions for other succeeding stages are available it passes into the next stages and completes the life cycle. The

* *Vide* Article on Vernalization—A New Russian Method of Crop Production by A. K. Mitra, Science and Culture, 3, 18, 1937.

technique of vernalization rests on this important consideration of the subjection of seeds to a suitable low temperature to complete this stage before sowing, which is technically known as vernalization stage. The reduction of total growth period is thus attributed to the completion of the thermo-stage by the developing embryo while lying inside the seed. Before the thermo-stage can be effectively developed, it is necessary to determine the precise conditions required for its rapid completion in different varieties. Failures in vernalization experiments are mostly due to the incomplete knowledge of these conditions. In the thermo-stage of development, temperature and moisture content of seeds are the two principal factors on which depends the efficiency of vernalization, and both are linked together in their action. The vernalization technique demands that the seeds should be soaked before temperature effect is applied and it is to be noted that moisture content of different varieties will vary as also the temperature of germination. Experience in the past has shown that in the pre-sowing treatment, it is moisture content of the seeds, and not the temperature, which is the critical factor and that this should be regulated according to the vernalization temperature. The lower the temperature the higher should be the humidity of the seeds; a suitable combination of these two is all that is necessary along with an adequate supply of air.

Photo-stage- The next important stage for plant development is the photo-stage depending on the period of illumination available to the plant. After the thermo-stage is over, the plant passes to the photo-stage where different light-periods are necessary for different plants. According to the variation in day length required for flowering, plants are classified as short-day plants requiring light for less than 12 hours a day and as long-day plants where the required light per day is more than 12 hours. This phenomenon of the response of plants to the relative length of day and night in flower production has been known as photo-periodism and the term photo-period is used to designate the favourable length of day for each plant. The importance of photo-period is too well known; some plants fail to produce flowers when the precise period of illumination is not available. Under such conditions plants will not flower but continue vegetative development even when Lysenko's stage of vernalization or the thermo-stage is effectively completed. When the thermo-stage is traversed by the plant, the plant will need proper light for flowering and these needs to be adjusted for each variety before vernalization experiments are put into practice. It is to be noted that the temperature condition is also very important at this stage. The works done at the Russian research stations indicate that for the second stage also every variety has its own temperature requirement. It is extremely important to study the temperature condition of different crops in the second stage. In some varieties of barley it has been shown that the second development stage is never completed at a temperature of +7° to +8° even with optimum light condition. Varieties of wheat growing in the north of Russia are very sensitive to temperature for the photo-stage; such plants when grown under favourable light conditions in the far northerly research station in Russia, were very adversely affected in their second developmental stage due to the prevalence of very low temperature. High temperature is generally necessary for traversing this stage. Russian agronomists have met with considerable difficulties in cultivating long day plants, like spinach and beet in the extreme north. Spinach is considered to require a high temperature either for the first stage or for the second stage. Temperature in those regions is very low and the duration of light may be more than 15 hours, but even then, owing to low temperature, plants fail to form seeds. Potato, on the other hand, behaves differently in its photo-periodic relation to temperature and although a long day associated with high temperature is the optimal conditions for tuber formation yet with low temperature sufficient tubers are formed. Thus, the temperature-requirement of one stage is quite different from that of another stage; temperature for the thermo-stage may be as low as −2°, while high temperature is generally necessary for the photo-stage.

Third stage After the end of these stages, completion of another stage is necessary for the formation of seeds and it is associated with gametogenesis. It is considered that the formation of

normally functioning gametes depends upon some preliminary phasic changes in the cells of the gametophyte and that these changes represent a separate developmental stage following the photo-stage. What this stage is, is not precisely known but it is certain that this is connected with the development of sexual elements. This stage is considered to have an important bearing on the problems of pollen sterility, frequently observed in Green Houses during the winter. It has been found that one of the main factors of this stage is light, its duration being shorter than that of the photo-stage. That this stage is a distinct separate stage is evident from some experiments carried out on the development of pollen grains. After germination an exposure of continuous light for 30 days was given to some wheat varieties, this effected the completion of the photo stage as all the plants produced stems and ears. The plants exposed to light for 4 hours became sterile, but this sterility could be overcome if long-day conditions are applied for 2 to 4 days just after the completion of the photo stage. Subsequent illumination for 4 hours would not prevent the setting of seeds. Under such circumstances long day plants will form seed even under short day conditions.

Light-vernalization—Apart from low temperature vernalization claims have been made by a number of workers that the process of hastening flower production can be effected by light alone. In Russia light-vernalization has been practised where no natural vernalization by low temperature is possible. Vernalization by light is generally done by an exposure to continuous illumination and this is more effective when it is applied from the time of seeding emergence and is slower when it is applied at the tillering stage. The results of some experiments carried out in Leningrad are interesting to note. Winter rye when vernalized by an exposure to continuous light came into ear within 64 days from sowing, while an initial period of short day followed by 24 hours of light delayed flowering to 87 days. Spring varieties of wheat, barley and mustard when grown in a 10-hour day are very much retarded in reproduction and produce more leaves, but when they are transferred to long-day treatment, they develop into vigorous plants and reproduction immediately sets in. Long-day vernalization is found to be very effective in spring forms producing early flowers, whereas in winter varieties the process is very slow.

During the last 3 or 4 years, important investigations on vernalization have been made by Prof. Gregory and Dr Purvis in the Research Institute of Plant Physiology, Imperial College, London; attempts have been made to elucidate the physiological processes involved in vernalization. In general, experimental results similar to those of Lysenko and other workers in Russia have been obtained. Vernalization of winter rye at 1° was very effective in the development of flowers. They have also shown that low temperature is not the only factor for hastening flowering; exposure to short days in the early stages of growth has also resulted in accelerating flowering, but continued short-day treatment is of no benefit. Earlier flowering is obtained by an initial period of short day followed by long day in these long day plants. As mentioned before, in the opinion of Lysenko, the thermo-stage is first of all traversed by the plant, then progress towards flower development becomes possible, otherwise not. But Gregory and Purvis have shown that this is not always the case; in winter rye without low-temperature treatment flowering is accelerated by a preliminary treatment of short days. Thus vernalization can be effected both by low temperature as well as by short-day exposure in the early stages of growth. This investigation of Gregory and Purvis further advances our knowledge of the problems of vernalization by light by showing that not only continuous light, but short-day exposure at the initial period in some plants, may be effective in hastening flowering. Further investigation in this line will be able to direct what are the plants that would respond to vernalization by short days. It has been determined by them that after a certain number of leaves are formed, a double nature of the primordia appears on the growing stem; the cells of this double ridge may produce either a leaf or a spikelet according to the condition of day-length or of temperature during germination in winter rye. The vernalizing effect is to arrest the development of these cell groups leading to leaf production and initiate the development of others leading to flowering. Low temperature of germination and short-day exposure are both effective in arresting the development of

leaf initials and encouraging the flower initials to flower production. It has been shown that these factors act quantitatively on the development of different phases, since by increasing the duration of treatment the leaf number is progressively reduced with a corresponding earliness of the maturation of the grains. Important point of vernalization is to reduce the leaf number and the following data of Gregory and Purvis (Table 1) from the low temperature vernalization of winter rye show that the variation in the leaf number is the deciding factor when flowering should take place.

TABLE 1.

Vernalized days.	Days from planting to flowering.	Mean number of leaves.
4	*	24.4
7	130	20.0
11	91	18.7
14	87	17.0
21	76	18.2
28	67	11.2
35	55	10.6
42	56	10.7
49	49	9.9

* Four day treatment has little vernalization effect, the number of days from planting to flowering being almost equal to those in normal autumn sowing and spring-flowering in winter rye.

Vernalization for a period longer than 5 to 7 weeks was ineffective in further reducing the total period of flowering. In the case of short-day exposure, the reduction of leaf number to a minimum of 16 occurs after 6-week treatment and the magnitude of the effect of this treatment increases with length of treatment up to 6 weeks, but longer exposure retards flowering.

Hormone theory Gregory and Purvis have put forward a hypothesis to explain the physiological processes involved in vernalization. They suggest that during vernalization an accumulation of some substance of hormonal nature takes place in the embryo which is the precursor of flower formation. The substance is supposed to be translocated and accumulated in all growing points of the shoot and when a critical concentration is reached it induces flower initiation. The evidence for the presence of specific hormones in the grains has also been presented by other workers—Cholodny, Dagys and Schander. Conclusions have been drawn that the hormone, resembling auxine in its physiological effects, is confined to the endospermic part of the seed and appears only after water absorption, from where it is transferred to the embryo. The stimulus of germination thus depends on the translocation to the embryo of this activating substance, which in the case of rice may be seen after 6 hours of water absorption. On the contrary Gregory and his collaborators have succeeded in vernalizing the excised embryo from dry grains of rye and this growing embryo is considered by them to be able to synthesize hormones from sugar, inorganic nitrogen and salts. It was also determined that when sugar is withheld, the excised embryo shows in complete vernalization. This dispenses with the older view of the formation of hormones in the endosperm outside the embryo.

Vernalization in India—The work done on vernalization of Indian crop plants has not yielded any positive results upto now and it remains to be seen how far the process could be used successfully in India. One of the chief difficulties of agriculturists in India is to fight against the uncertainties of weather conditions. It often happens that these do not permit having a particular crop standing in the field for a long time owing to the possibility of damage by excessive rain or by high temperature. Ravages of frequent floods in the fertile lands of India are too well known. Under these adverse conditions of agriculture, it will be a great boon to the agriculturists if the crops could be harvested in a very short time during which unfavourable weather conditions might not set in. Some of the difficulties in agriculture could certainly be overcome by the method of vernalization. Unfortunately not many attempts have been made in India and positive results obtained. A suitable technique of vernalization for a particular crop is beset with considerable difficulties and to this is added our ignorance of the developmental phases of tropical

plants and of the environmental factors influencing them. These two reasons together would account to a great extent for the failure of experiments made in India. The technique of vernalization was applied to Indian crops like wheat, barley, cotton, rice and sugarcane, and the results, so far available are not of any practical value. Against the failures from different places, it will be interesting to note the results recently published from the Vivekananda Laboratory, Calcutta, by B. Sen and S. C. Chakravarty (*Ind. Jour. Agri. Sc.*, *8*, Part III, 1938). In their preliminary experiments the possibilities of extending vernalization to mustard seeds for agricultural purposes have been presented. The seeds were subjected to low temperature treatment at an advanced stage of germination (sprouted seeds) for a period or 15 days, resulting in an earliness of maturity by 23 days, while in the case of seeds soaked in water for 24 hours and chilled subsequently for 13 days, the flowering period was reduced by 10 days in comparison to the unvernalized seeds. Possibilities of further reduction with a longer period of chilling are being investigated. Although the degree of vernalization induced is less in the latter treatment, its advantages are (*i*) retaining the power of the germination when dried and transported to other regions, and (*ii*) germination of almost all the seeds, which in the case of sprouted seeds was thirty to forty per cent. One great significance of drying the vernalized seeds is the possibility to distribute them to cultivators from the Government agricultural farms, thus relieving the cultivators of necessity to maintain an expensive equipment for vernalizing their seeds. The distribution of vernalized and air-dried seeds is done in some parts of Russia, Belgium and France.

It is desirable that other workers, having developed a suitable technique, should take up the problem of vernalization of crops like rice, wheat, cotton and jute, which have been successfully vernalized by workers outside India. In Russia some varieties of Indian wheat have showed a marked response in that the vernalized plants have eared while the unvernalized ones did not even form stems. No attempt has so far been made with jute. Some varieties of cotton have been successfully vernalized in Russia and Czecho slovakia. Vernalization of Robarello rice (a non-Indian variety) is recorded from Holland. It is a well-known fact that in Bengal two varieties of rice *Aus* and *Aman* have different times of ripening. *Aman* variety flowers at a time when the day length is less than 12 hours a day, while *Aus* rice ripens when the day length is more than 12 hours. *Aman* rice is superior in yield, quality and food value; on the other hand, *Aus* has one important advantage of earlier ripening. An attempt to induce *Aman* to flower at the same time when *Aus* is in flower will have great significance in hybridization for combining the desired character of these two varieties. The technique of vernalization has been found to alter the flowering period of many cereals in Europe. Gregory and Purvis have reported that "the winter rye could be converted into a state indistinguishable, so far as flowering is concerned, from spring rye". Rasumov has shown that in millet, an exposure to short days in the early stages of growth accelerated flowering under subsequent long days although the plant is a typical short-day plant in its flowering behaviours. *Aman* paddy in Bengal is a short day plant, so vernalization in the early stages of its growth by an exposure to short period of illumination may induce the flower formation at a time when *Aus* variety flowers under Bengal conditions. It may be mentioned here that an investigation on these lines is proposed to be undertaken in the University Botanical Laboratory, Calcutta with a view to find out the agricultural importance of vernalization so far as the cultivation of rice in Bengal is concerned.

On the Bicentenary of the Birth of Sir William Herschel (1738-1822)

THE bicentenary of the birth of Friedrich Wilhelm Herschel, the famous astronomer who was born German but turned English, has recently been celebrated with due reverence and appreciation all over the astronomical world. His life in brief, is the story of the transformation of a musician into the greatest astronomer of his time, who preferred the music of the spheres in the great ocean of space to the symphony of the orchestra. His enthusiasm and love for the denizens of the sky was so great that he converted even his brother and sister to his faith, and this sister Caroline Herschel later became his indefatigable assistant both in observations and computations, and also acquired reputation as astronomer by independent observations and discovery.

Wilhelm Herschel was born on the 25th of November, 1738 in Hanover, as the third child of a musician attached to the Hanoverian Guard. The family was poor, and Wilhelm in order to be helpful to the family became oboist in a military Band at the age of fourteen. This opened before him the career of a musician, and determined the course of the first part of his life. In 1763 young Wilhelm came to London to seek fortune with an empty pocket. He worked as an organist at Bath, and by 1766 became the leading musical authority there. Six years later, his brother Alexander and sister Caroline, both musicians, joined him at Bath. It looked as if musical career was going to be the aspiration of all the brothers and sisters. But the intellectual curiosity in Herschel was too strong to be satisfied by music, and soon something happened which entirely changed the course of life of this little colony of brothers and sisters at Bath.

In 1773 Wilhelm bought a copy of Emerson's Trigonometry, and an astronomical work by Ferguson. After a day's work of 14 to 16 hours, Wilhelm retired to bed with his books, and thus began his first lessons in Astronomy. He was so captivated by the descriptions of astronomical bodies that he was seized with an ardent desire to look at the sky through a telescope. As telescopes were dear in those days he determined to build one himself. After a few trials with lenses fitted to long tubes, which produced magnification but were unsuitable for observations, he set about making a Gregorian telescope with the help of an amateur at Bath, who made and polished mirrors. Soon William learnt the art himself and began polishing large mirrors. The whole house was turned into a workshop where the brothers and sisters were all engaged in grinding glass, polishing mirrors, making stands, tubes, etc. The Piano came to occupy a secondary position in the household.

Soon Herschel started regular observations and kept notes. The day was still given to music lessons but every available hour of the night was devoted to astronomical observations with the telescope of his own make. The plan of his observations was to make a methodical study of all parts of the heavens, to make parallax measurements of stars in order to find their depths in the sky, and ultimately to determine the structure of the Universe.

The first capital discovery of Herschel, still an amateur astronomer, was made on the 13th March, 1781, when late in the evening he observed rather a curious star with a visible disc in the Constellation of Gemini. This was first suspected to be a comet, but was later found to be a new planet beyond Saturn which in those days was supposed to mark the boundary of the planetary system. Herschel named the new planet Georgium Sidus, as homage to King George III, but the Greek name Uranus, father of Saturn received preference at the hands of Astronomers. Even to this day the symbolic letter used for Uranus is H, in memory of the discoverer. Herschel was awarded the Copley Medal of the Royal Society for the discovery.

The new discovery made Herschel famous making him known to all the professional astronomers of Europe at the time, but his financial position remained where it was. The music lessons by day still continued. Besides Herschel also occasionally made a little money by making and selling telescopes to kings, princes and noblemen of Europe. It is said, he made over 400 mirrors with his own hand. At length an offer came to Herschel from King George III himself to give up music and become private astronomer to the King on an annuity of £200. The musician now became the professional astronomer. On the 19th May, 1782, William and Caroline played and sang for the last time in public at Bath. They removed first to Datchet, and later to Slough which was Herschel's place of work till his death.

The astronomical contributions of Herschel are so numerous that only the outstanding features of his discoveries can be mentioned. In the planetary world he not only discovered Uranus, but also two of its satellites which move in orbits almost perpendicular to the orbit of their primary. Besides discovering a couple of Saturn's moons, he made many observations of the Sun, Moon and the planets to obtain information about their surface features. He is the first discoverer of the curious white spots in the polar regions of the planet Mars, which he concluded to be polar patches of white snow. This is interesting as we know that the believes in "canal theory and human habitation in Mars" exist even to the present day. Herschel made many careful observations of the times of rotations of planets and satellites about their axes to examine if there is a relaion between the times of axial rotation of a satellite and of its revolution round the primary, such as exists in the case of the earth moon system.

Herschel studied large numbers of groups of close stars between long intervals of time, and from the relative shifts of these stars discovered the existence of binary and multiple systems of stars which move round one another according to Newton's laws of gravitation. He also discovered that our solar system has a motion in space towards the Constellation of Hercules.

But none of his achievements surpass in grandeur his discoveries in Sidereal Astronomy. His ambition was to study the stars in every part of the sky and measure their distances from us and from one another. By his "star gauges" he was the first to form an idea of the immensity of the Universe of stars, and nebulae of which he is the discoverer of many. To Herschel we owe the term "Island Universe," so popular in our day, which he applied to distant nebular systems floating in the great ocean of space outside the Milky Way as quite independent systems. He has left us many details about the relative brightnesses of stars, their magnitudes, colour indices and distributions in space.

With a subvention from the King, Herschel installed in 1789 at Slough his famous 40 feet Telescope, which was the biggest telescope of that time.

Herschel received many honours in his later life. He was elected President of the Royal Society and was the first President of the Royal Astronomical Society. Académie des Sciences of France honoured him by electing him Member of the Institute. In 1816 he was knighted and became Sir William Herschel.

Herschel the man was quite as great as Herschel the astronomer. He was simple and modest and always ready to help workers by his vast knowledge and experience.

Sir William Herschel died on the 25th August, 1822, leaving his worthy son to carry on his work. His epitaph truly summarises the mission of his life "*He broke through the barriers of the skies.*"

N. R. S

Is Life Possible in Other Planets

K. R. Saha and A. K. Saha

An observer on the earth familiar with so many varied and intricate forms of life often wonders whether there is any other place in the universe where parallel forms of life may exist. If there be such a place anywhere in the universe, it must be favoured with physical conditions and environment similar to those reigning on our globe. Of course, such thought could not exist amongst mediæval people, who were under the impression that the earth was the main thing in the universe and every other thing *e.g.*, the Sun, the Moon, the Planets and the Stars—was secondary to the earth and its inhabitants. But when Copernicus proved that the earth was not the centre of the universe, but was one of the five planets all revolving round the sun, many questioning minds began to ask themselves whether these planets might not be inhabited by intelligent beings. The curiosity became stronger when Galileo (1564–1642 A.D.) demonstrated with his newly-invented telescope (1609) the physical resemblance of Mars, Venus and our own planet.

The Canals on Mars

The belief in the existence of life on other planets was further enhanced when

Photograph of Lowell's Mars Globe for observing Season of 1916.

Schiaparelli, the well known Italian astronomer, in the latter half of the 19th century thought that he had discovered the so called canals* on Mars. These are some dark markings which Schiaparelli imagined that he had seen on the surface of Mars when looking through his telescope. He had further support in this speculation from the American astronomer, Dr Percival Lowell, who went so far as to conclude that the canals were irrigating channels artificially controlled by some highly intelligent beings inhabiting the surface of Mars. This explanation received great popular reception and some imaginative novelists like Mr H. G. Wells even described the Martian beings as having very curious anatomical structure and possessing highly-evolved intellect. But astronomers have not in general been agreed on the question of the existence of these canals. Some are of opinion that the so called canals are merely optical illusions and are due to the personal equation in the sub-conscious operation of the observer's mind. There is enough ground for such optical illusion, for even when Mars is nearest to us, it has an angular diameter of 25 seconds, and even with the most powerful long-focus lens, (*e.g.*, that belonging to the Mt. Wilson Observatory), the diameter of the image of Mars on a screen would only be ¼ inch. The resolving power, *i.e.*, the capacity of an optical train to show details, of even the Mt. Wilson system is not powerful enough to show such details, as say a canal of 10 miles breadth on the surface of Mars. But though direct telescopic vision or even photography may fail to give us any precise information, we may turn to the spectroscope which gives very sure results. Direct observation allows us, however, to

*The idea of existence of canals on Mars was not started by Schiaperelli—he saw straight lines of uniform thickness and called them by the Italian word 'Canalli—long, thin lines.' On account of similarity of the pronunciation of Canalli with the English word canal, the meaning was confused and later on came to stay on in the sense of canal only.

form a somewhat approximate idea of the conditions prevailing on the surface of a planet.

The result of such investigations may be shortly summarized. Mercury, which is of all the planets nearest to the sun, appears to be completely barren; Venus has an extensive atmosphere of carbonic acid gas, Mars is almost completely deprived of oxygen, and the bigger planets have atmospheres of ammonia and methane. Hence they do not appear to support life other than very rudimentary forms and certainly not those that we know on the earth. Science thus answers today quite decisively the question which has so long been debated. The earth is the only planet within the entire solar system where common everyday forms of life exist. Let us now proceed to a more detailed discussion.

Conditions for Existence of Life

It should be clear, in the very beginning, that whenever we speak of ' life ' in this article we mean only those forms of life with which we are familiar on this globe of ours. Any form of ' life '—animal or vegetable—on the earth demands some fundamental requisities for its existence. First, there must be a system of organized living matter which will constitute the *physique* of the form of life under consideration. The fundamental basis for living beings on the earth is a series of compounds of carbon, hydrogen and oxygen in the main, and of other elements like nitrogen, phosphorus, calcium, sodium and iron to a lesser extent. Secondly, we need some substance in the environment which will react with living matter, liberating in the process energy which is necessary for its growth and maintenance. For plants these substances are some very simple inorganic salts in the soil, carbon dioxide in the atmosphere and water in the liquid state. During the day, the plants absorb carbon dioxide from the atmosphere and simple mineral salts from the soil; solar radiation falling on the leaves or on green vegetable matter converts them photosynthetically into a series of compounds of carbon, which build up the body of the plant. During this process, energy is absorbed from sunlight, and oxygen is set free in the atmosphere. In the night time, and sometimes even during the day, the reverse process takes place,—oxygen is absorbed which burns the carbon compounds in the tissues of these plants, carbon dioxide is liberated and energy is set free. In animals, however, the storage and consumption of energy do not take place in the same way. An animal has to consume food, a fraction of which is used for repairs and developments of its living parts and the remainder is changed by the process of digestion into relatively complicated, carbon compounds which are burned by the inhaled oxygen with the liberation of necessary energy and the carbonic gas is exhaled out from the system as a waste product. This, in brief, is the story of vegetable and animal life as we know on the earth. Hence oxygen and carbonic acid gas are both simultaneously necessary for the existence of life.

The third necessity is a liquid which will interpenetrate the living matter and make mechanical operations and chemical reactions possible. Chemical reaction is inconceivable between entirely dry solids. For all the different forms of life on the earth, this liquid is water and consequently we may take water as an absolute necessity for any form of life akin to that on the earth. The fourth and the most fundamental necessity is an external source of radiation. For without radiation, none of these life-processes can take place. For the earth and the other celestial bodies of the solar system, this source is the sun. The fifth necessity is a reasonable range of temperature for molecular reactions to take place neither too slowly, nor too rapidly. Prof. N. V. Sidgwick in his Maiben lecture before a meeting of the American Association for the Advancement of Science suggested that the upper limit of temperature for any molecular reaction should be 6000°K which is the temperature of the outer surface of the sun, and the lower limit 100°K. The reason for this choice is that beyond the upper limit, molecular agitation and collisions become too vigorous for the molecular structure to persist and molecules break up into atoms and electrons, while below the lower limit the molecular energy is too small to show any chemical activity. But for our purpose, we need a much narrower limit, since we must have oxygen and carbonic acid gas present in the atmosphere and water present on the surface of the earth in its liquid state. The limit should further be such that the intricate and complex compounds of carb

which constitute the living body show neither chemical lethargy nor a tendency to break up too rapidly. We may therefore safely put the limit as lying between 50°C and 227°C. Mr H. G. Wells has summarized these possibilities in his *Science of Life*. He writes:

" Life as we know it seems to be attached to and dependent upon......complex chemical compounds of carbon, nitrogen, hydrogen, oxygen and other elements; but we are really not limited to such compounds, nor to the limiting temperature and pressures within which they can play their parts, once we allow our minds to move beyond the life we actually know. We can conceive vaguely of silicon playing the part of carbon, sulphur taking in the role of oxygen, and so forth, in compounds which, at a different tempo, under pressures and temperatures beyond our earthly ken, may sustain processes in movement of metabolism with the accompaniment of some sort of consciousness, and even of individuation and reproduction. We can play with such ideas and evoke, if we like, a Gamma life, a Delta life and so on through the whole Greek alphabet. We can guess, indeed, a sub-conscious and super-conscious aspects to every material phenomena. But all such exercises strain the meaning of the word *life* towards the breaking-point, and we glance at them only to explain that here we restrict our use of the word ' life ' to its common every-day significance of the individual reproductive, spontaneously stirring and metabolic beings about us."

Study of the Surface and Atmosphere of Planets

It is evident from what we have said above that an atmosphere of oxygen, and carbon dioxide and liquid water within a temperature range of 100°A to 373°A is the *sine qua non* for the existence of life on any planet. Hence we first turn to examine the composition of the atmosphere of a planet, its pressure and temperature. It is the study of the atmosphere alone that may sometimes give us a decisive answer to the question on the possibility of existence of the conditions of life on the surface of other planets. Before dealing with the delicate experimental evidences, obtained from the telescope and the spectroscope, let us have some preliminary discussion based on dynamical arguments on the physical conditions prevailing on different planets of the solar system.

The first will be about the existence of atmospheres whether every planet can have an atmosphere at all.

Dynamical Considerations

It is common knowledge in dynamics that the path of a stone projected on the surface of the earth is a parabola. But from strict considerations of dynamics, it can be easily proved that this path is an ellipse with the centre of the earth as the distant focus. It can also be shown that it is not always an ellipse. If the velocity of projection is gradually increased, after a certain limit the path no longer remains an ellipse. When this limit is reached, the path becomes a parabola and if it exceeds this *critical velocity*, as it is sometimes called, the stone moves in a hyperbola. In the last case, the projectile will certainly overcome the planetary attraction and move away in space till it is captured by the sun or some planet or gets lost in space. This velocity of escape is given by the relation: $V^2 = 2\gamma M/r$, where M is the mass of the planet, γ the gravitation constant and r the planetary radius. The values of this velocity for different planets are given in the following table:

Mercury	..	..	4.3	km/sec.
Mars	..	..	4.9	,,
Venus	..	..	10.0	,,
Earth	..	..	11.3	,,
Jupitor	..	..	58.0	,,
Moon	..	..	1.7	,,

The reader may ask: what has all these to do with the question of existence of an atmosphere on a planet? For this, we require a little degression into the kinetic theory of matter which represents a gas as consisting of molecules, each a tiny particle, moving in all direction with velocities ranging from zero to infinity. The mean square velocity of the molecules is given by the relation:—

$$C^2 = 3RT/M$$

Thus C^2 is proportional to the absolute temperature and inversely proportional to the molecular mass.

The values of C, for different gases at different temperatures are given in the following table:—

Values of C at different temperatures in km/sec.

Gas		Temperature.	
	100°C	0°C	300°C
	Velocity	in kilometers	
Hydrogen ..	1.47	1.80	2.66
Helium ..	1.04	1.31	1.90
Water-vapour ..	.49	.61	.88
Nitrogen ..	.39	.49	.71
Oxygen ..	.37	.46	.67
Argon	.33	.41	.59
Carbon dioxide ..	.31	.39	.57

It is seen from the table that the value of C for most of the gases is much less than the velocity of escape for the earth, which is about 11.3 km/sec. The table also shows that the value of C increases with temperature as would naturally be expected from kinetic theory considerations. Though apparently the value of C at the temperature of the earth's surface is considerably less than the velocity of escape, we can explain in the following manner why the earth is now completely deprived of hydrogen. This loss has taken place gradually and it is readily understood if we are at liberty to contemplate an epoch of time in the evolution of the earth, when the temperature must have been very high; say, when the earth separated from the sun, the temperature must have been 6000°C. At such a high temperature the mean velocities of H_2-atoms would be 12.8 km/sec., and that for H_2-molecules would be 9 km/sec. So a mass like the earth, just separated from the sun, would readily lose all hydrogen atoms and most of the hydrogen molecules. But even if the temperature is much lower, there would be steady loss of the lighter constituents, for according to Maxwell's law of distribution of velocities, all molecules in a mass of gas do not move with the same velocity; there are some whose velocity may even at the ordinary temperature, exceed that of the velocity of escape from the planet, and such particles will therefore escape. The rate of loss will increase with temperature and fall with lower molecular weight. Jeans has in fact calculated the time required for loss of planetary atmosphere from different planets and for different temperatures. He finds that if the mean velocity of the gas is one-fourth the critical velocity of escape, the atmosphere would be lost in 50,000 years. But if the ratio is one-fifth, 25 million years would be needed for complete loss.

These considerations show that small bodies like the moon and the asteroids cannot retain any atmosphere, for the critical velocity of escape is too small.

On the other hand in the case of the major planets, the critical velocity is very high (for Jupiter it is 58 km/sec.), and temperature is at the same time very low; hence they are likely to retain even all their hydrogen even after their separation from the sun and as we shall see later on, this is actually the case.

The earth and Venus have probably lost all their hydrogen and helium in the past, but retained the heavier gases. Mercury being very near the sun, has generally a very high temperature, hence it must have lost its whole atmosphere. It is only Mars whose position is intriguing.

Observational Tests

Many direct observational methods have been adopted in recent years to study with some degree of precision the existence of atmosphere on planets, the most important of them being

(*i*) the measurement of the albedo,
(*ii*) the study of the twilight arc and
(*iii*) the analysis of the spectrum of light reflected by planets.

The Albedo.

The albedo of a planet is the ratio of the amount of light reflected to the total radiation incident upon it from the sun *i.e.*, total diffuse reflecting power. By suitable photometric measurements the albedo for different planets has been determined and the following table gives its value for the principal planets and the moon.

Mercury	0.075
Venus	0.62
Earth	0.43
Mars	0.154
Jupiter	0.42
Saturn	0.45
Moon	0.065

To understand these figures, let us now see what are the causes contributing to the albedo. The light which is returned from a planet is made up of light reflected from the clouds in the planetary atmosphere, the light reflected by Rayleigh-scattering by the molecules forming the atmosphere and lastly the light reflected from the solid surface. It has been estimated that of the 43% of light reflected from the earth, 8% is returned by the solid surface, 7% by Rayleigh-scattering by the atmosphere, and 28% by the clouds in the atmosphere. Bearing this in mind, we can now interpret the values of albedo for other planets.

The very low value of albedo for Mercury and Moon indicates that they do not possess any atmosphere to reflect the solar radiation falling upon them from the sun. The high values for Venus, Jupiter, Saturn and the outer planets indicate the existence of dense clouds. The Earth and to some degree Mars, which are only partially eclipsed by clouds have albedos intermediate between those of Mercury and Venus.

The Twilight Arc Phenomenon

Another very conclusive way of detecting the presence of an atmosphere on a planet is the observation of the phenomenon of twilight arc. This has been observed for the planet Venus near the position of inferior conjunction, when the horns extend much beyond the diameter. On such rare gibous phase, the planet is within one degree of the sun, which happens at a beginning of a transit of this planet across the solar disc, the horns extend so much that a complete ring of light is observed round the planetary disc [Fig. 2 (c)]. This phenomenon has also been observed for the planet Mars. At the time when this planet should exhibit a gibous phase, the distance of the terminator from the opposite limb is found to be greater than the theoretical value. To explain these facts we have to bear in mind that if a planet is covered by an aerial envelope, it behaves like an optical lens. If a body like the moon is completely devoid of any atmosphere, sun-light will fall directly on one hemisphere and the different phases shown in Fig. 2 (a)

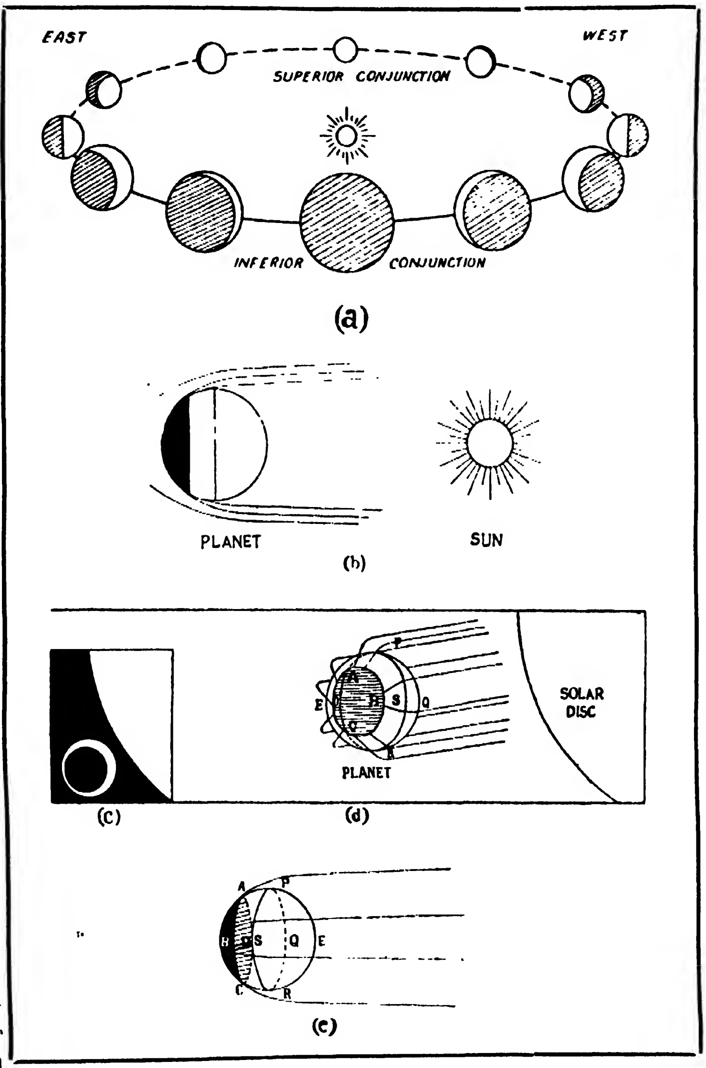

Fig. 2.

would be visible to an observer on the earth at different stages of the planet's revolution round the sun. If on the other hand, sun-light has to pass through an atmosphere, it would suffer refraction and bend round curves and more than half of the planet is illuminated [Fig. 2(b)]. Consequently, when the planet is beginning a transit across the solar disc, [Fig. 2(d)], an observer on earth would see the thin crescent phase PQRS plus the extra lighted surface PSREABCD. The segment above the shaded area ABCD would be the only portion completely devoid of light. As a result, to a terrestrial observer the horns P and R would seem to run together giving rise to a complete ring of light round the dark planetary disc ABCD [Fig. 2(c)]. Similarly, when the planet is between the positions of superior conjunction and greatest elongation [Fig. 2(e)], the portion visible to an observer on the earth is the area PERS plus the area PSRCBA. Hence, the distance between the terminator line ABC and the opposition limb PER *i.e.* the distance BE is greater than the theoretical value SE. It should be observed that the lines bounding the visible areas are never distinct due to floating dust particles illuminated by incident sun-light.

Spectral Analysis

The most effective way of detecting an atmosphere is the spectroscopic method which enables us not only to detect the gases present, but also to determine their actual amounts with certain degree of confidence. A spectrum of the sun directly photographed on the surface of the earth is a continuous band of light crossed by a large number of dark lines most of which originate in the reversing layers of the sun. But some of these lines are due to absorption by the atmosphere of the earth, such lines being called *telluric* lines. These may be distinguished from the lines originating from the sun's atmosphere by the application of Doppler-Fizeau principles. A shift from the mean position is observed in the cases of lines due to the sun in a photograph of the spectrum of sun-light coming from either limb of the solar disc, which may either approach or recede from us on account of the rotation of the sun about its axis; telluric lines on the other hand remain fixed in position. The telluric lines may also be distinguished by comparing the Fraunhofer Spectrum of the sun taken at the zenith and at the horizon of the earth. They show variation in intensity in the two cases due to passage of sun-light through different thicknesses of atmosphere. As examples of telluric lines, we may mention the dark bands of oxygen in the spectrum of the sun lying in the red and infra red region. These were designated by Fraunhofer by the letters A and B. On using a highly dispersive spectrograph these bands resolve into a series of doublets placed at regular intervals of which the head of the band A is at 7954°A and that for the band B at 6867°A; other telluric lines are due to water vapour (the so-called rain bands); these lie mostly in the red and the green parts of the solar spectrum and their intensities are greatly dependent on the hygrometric state of the terrestrial atmosphere. The presence of ozone and carbon-dioxide are also manifested by respective lines in the solar spectrum. The spectroscopic method however fails in the case of nitrogen and hydrogen and the inert gases for their lines lie far away from the visible part of the spectrum in the ultra violet region. Let us now see how spectrum analysis can be applied to find out the constituents of atmospheres of planets. In this case we have to make a special analysis of the solar radiation reflected from a planetary surface. As this radiation has also to pass through the earth's atmosphere, the sepctrum so obtained shows absorption bands of the planetary atmosphere plus those of the terrestrial atmosphere. Hence the absorption of the planet's atmosphere is to be obtained as a differential effect. This is a very difficult process, but has been solved as a result of successive efforts by St. John and Nicholson, Adams, Dunham, Adel, Slipher and others. The results however will be discussed in a greater detail under each planet.

(To be continued).

On the Theory of Heavy Electron

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In recent years a large amount of work, both theoretical and experimental, has been done on the theory of atomic nuclei, which are characterised by their electric charge, mass number, spin, magnetic moment and statistics. The nuclear constituents are now well recognised to be the protons and the neutrons.* The force between them is definitely not electrical in origin but is a certain type of exchange force showing saturation. According to the Fermi theory of β-decay this exchange force was supposed to consist in the virtual emission of electron and neutrino (or positron and anti-neutrino) by the neutron (or the proton) and their absorption by the proton (or the neutron). The gravest difficulty of this hypothesis was that this gave a very small order of magnitude for the nuclear forces, which is entirely incompatible with experimental results. Several suggestions were put forth to remedy this defect. (*i*) the interaction leading to emission is only a part of a more general interaction, (*ii*) the expression for the interaction in the β-theory probably contains higher derivatives of the electron and the neutrino wave functions, (*iii*) the behaviour of the electrons of wave-length near $r_0 = e^2/mc^2 \simeq 2.8 \times 10^{-13}$cm may be entirely different from the usual ones. But all these hypotheses are still vague and no progress was made along these lines. The most interesting suggestion was made by Yukawa (*Proc. Phys. Math. Soc.*, Japan, *17*, p. 48, 1935), who assumed the existence of a particle obeying Bose Statistics, having the elementary electric charge ($e = +4.77 \times 10^{-10}$ e.s.u.) and mass intermediate between that of proton and electron. He also predicted that it would be rather impossible to detect these particles in ordinary nuclear processes but they may be found in cosmic rays. As the particles were not known to exist experimentally, the theory was not considered to be of any great use.

Recently new interest has been aroused in this hypothesis due to the recent experimental evidences for the existence of the heavy electrons in the penetrating components of the cosmic rays. The mass of the heavy electrons has been experimentally determined by many workers, notably Street and Stevenson (*Phys. Rev. 51*, p. 1005, 1937), Ruhling and Crane (*Phys. Rev. 53*, p. 2516, 1938), Auger (*Comptes Rendus*, Paris, *206*, p. 345), Nishina and collaborators (*Phys. Rev. 52*, p. 1198, 1937), and has been found to lie between 100 and 200 times the electronic mass. Still it has not yet been possible to attribute any definite mass to this new particle. The experimental results of Auger discussed in the Moskow Conference, a brief report on which has been given by A. Walter in *Physikalische Zeitschrift der Soviet Union*, *12*, p. 613, 1937, definitely show that the particles have a mass spectrum, while the careful analysis of cosmic ray data by Bhabha (*Proc. Roy. Soc. A 164*, 257, 1937) also indicates that heavy electrons of different masses are needed to explain the experimental results. For general considerations, therefore, these particles may be taken to have a mass of about 150 times that of the ordinary electrons. These particles are very unstable and have an average life time of about 2×10^{-6} sec. This view has been expressed by Euler and Heisenberg (*Ergeb. der. Naturwissenschaften*, *17*, p. 1-69, 1938) and experimental evidences in its favour have been discussed in recent notes of Blackett and Rossi (*Nature*, *142*, p. 992, 1938). Because of the mass spectrum these particles have been named 'Mesotrons' by Anderson and Neddermeyer. (*Nature*, *142*, p. 878, 1938).

Using the mechanism of virtual emission and absorption of the mesotron by the nuclear particles and adopting the scalar theory, Yukawa showed that the interaction potential between the neutron and the proton should be of the form $\frac{g^2 e^{-\lambda r}}{r}$ where g is a constant of the dimensions of the electric charge

* Articles on the Heavy Electron appeared in SCIENCE AND CULTURE, 3, Nos. 5 and 7, 1937-38.

and $1/\lambda$ defines the range of the nuclear forces and is given by the relation $\gamma = \frac{M_u c}{h}$, M_u being the rest mass of the mesotron and h is the Planck's constant divided by 2Π. Taking M_u to be 150 times the electronic mass this range is of the order 2×10^{-13} cm. This is quite in accord with the experimental results as the radius of the α-particle is roughly of this order. The greatest defect of the scalar theory has been that it makes the ^1S state of the deuteron to be stable while the ^3S state becomes unstable due to the repulsive potential. This obviously is in contradiction with the experimental results which definitely show that the stable ground state of the deuteron corresponds to the ^3S state. Also such a theory has been found to be inadequate to account for the magnetic moments of the neutron and the proton whose experimental values are $\mu_P = 2.9\ \mu_O$ $\mu_N = -2.2\ \mu_o$, where μ_0 is the nuclear Bohr magneton, and at the same time it leads to a wrong spin dependence of the nuclear forces.

Recently the problem has been studied by various authors and notably by Kemmer (*Proc. Roy. Soc. A 166*, p. 127-153, 1938) who has shown that there are four inequivalent but equally simple possibilities of the mathematical discription of the Einstein-Bose particles, but it is only for the vector formulism that the sign and the spin dependence of the neutron-proton forces are in agreement with the experimental results. The vector theory makes the ^3S state to be the stable ground state for the deuteron. The wave-function of the mesotron is, therefore, taken to be a four-vector and satisfies the first order linear differential equations proposed by Proca (*Jour. de Phys. et Radium.* 7, p. 347, 1936). These linear equations can be shown to be equivalent to a second order wave equation, very similar to the Maxwell equations of the radiation theory except for a term which contains the rest mass of the mesotron. Following the well-known procedure of quantisation given for the scalar case by Pauli and Weisskopf (*Helvetica Physica Acta.* 7, p. 709, 1934), it has been shown by Kemmer (*loc. cit.*) and Bhabha (*Proc. Roy. Soc. A 166*, p. 501, 1938) that to each mesotron there correspond two transverse waves and one longitudinal wave, while for the photons it is well known that there are two transverse waves and no longitudinal wave.

On the vector theory, the interaction potential between a neutron and a proton has been found to be of the form

$$V_{NP}(r) \left[g^2 + f \left(\vec{\sigma}_N\ \vec{\sigma}_P \right) + f^2/\lambda^2 \left(\vec{\sigma}_N \operatorname{grad} \right) \times \left(\vec{\sigma}_P \operatorname{grad} \right) \right] \frac{e^{-\lambda r}}{r}$$

where $\vec{\sigma}_N$, $\vec{\sigma}_P$ are the spin operators of the neutron and the proton and r is the distance between them. Taking into account the proper symmetry properties it has been found by Fröhlich, Heitler and Kemmer (*Proc. Roy. Soc. A 166*, p. 154, 1938) that for the case of deuteron,

$$^3S\text{—state} \quad V_{NP}(r) \simeq -(g^2 + \tfrac{2}{3} f^2) \frac{e^{-\lambda r}}{r}$$

$$S\text{—state} \quad V_{NP}(r) \simeq -(2f^2 - g^2)$$

showing that the potential corresponding to the ^3S term of the deuteron is always attractive. Since the potential corresponding to ^1S state is roughly half of that of the ^3S state, f and g are of the same order of magnitude and the numerical value is roughly given by $g^2/hc \cong 1/6$.

This theory leads to like particle interaction only as a fourth order process and the calculations of Fröhlich, etc. show that this leads to a strong repulsion for proton-proton force for distances less than $1/2\lambda$. Experiments of Tuve, Heydenburg and Hafstadt (*Phys. Rev.*, *50*, p. 806, 1936) on the scattering of protons by protons and interpretation of these results by Breit, Condon and Present (*Phys. Rev. 50*, p. 825, 1936) indicate that the forces between proton-proton must be attractive and that they are approximately equal to the neutron-neutron forces. A suggestion has been made to explain this by the existence of a neutral mesotron called '*Neutretto*' by Heitler. As yet there are no experimental evidences regarding the existence of such a particle, but some theoretical consequences regarding the like particle forces have already been worked out by Kemmer (*Proc. Camb. Phil. Soc.* *34*, p. 35

1938) and by Yukawa and his collaborators (*Proc. Phy. Math. Soc.*, Japan *20*, p. 720, 1938).

It may also be worth mentioning that it is possible to derive the relation $\frac{1}{\lambda} = \rho = \frac{h}{M_u c}$ where ρ the range of the nuclear forces by considerations based on the Heisenberg's uncertainty principle. This derivation has been given by Wick in a recent note (*Nature 142*, p. 993, 1938). In a transition of a neutron to a proton state the negative mesotron is only observable if the change of energy is of the order $M_u c^2$ where M_u is the rest mass of the mesotron and the time of observation is less than ρ/c where ρ is the distance between the neutron and the proton. Hence by the relation $\triangle E.\triangle t \geqq h$, $\rho \quad h \quad M_u c$. This really gives a lower limit to the range of the neutron proton force.

The various consequences of the mesotron theory, their annihilation and creation, the various possible processes of their energy loss when passing through matter, their bearing on the theory of β-decay and on cosmic ray phenomena, production of showers and bursts etc. are being studied by a large number of workers both theoretically and experimentally but still the whole subject matter is far from being fully understood.

Raising Standard of Living

ONE of the most welcome development in modern economies is the increasing emphasis on the aspect of consumption. The investigations made under the auspices of the League of Nations on the problem of nutrition and still more recently on measures for raising the standard of living offer welcome stimuli to such studies. The activities in these directions of the Economic and Financial Organization of the League, which is acting in some cases, with the collaboration of the International Labour Office, have directed the attention of Governments and public men to various urgent problems of economic and societal reconstruction, which learned economic treatises had been for years past emphasising, though without much appreciable effect on practical policy. The forum offered by the League of Nations in these matters is one of its most abiding contributions.

Prerequisities of a Rise

Recently a group of American economists and students of social science deliberated upon the "Essentials for Sustained Recovery." (*Proc. Amer. Aca. of Pol. Sc.* May, 1938). As is natural the subject of the standard of living loomed large in the discussion. Professor Frederick C. Mills of Columbia in discussing the prerequisites of raising the standard of living noted the apparent confusion in the ordering of the complex economic system under which we live. The "Prerequisites" that Prof. Mills emphasised were four fold, (*a*) advances in technical arts, (*b*) effective organization of the agents of production, (*c*) co-ordination of the elements of working economy and (*d*) rational utilization of the principle of division of labour. Needless to point out that though considerable advance has been made in all these directions, there are various developements inherent in the present position of industry where science could offer scope for greater rationalization. In fact, it is wellknown that not in a few cases has the rapid advance of technical change and invention been checked by the vested interests. Our national economic policies have also been responsible for limiting the pace of advance, as has been pithily said, "Living

standards the world over are lowered by compart mentalizing of economic activity."

Mr Ha 's survey,* issued by the League of Nations, is in the nature of a "preliminary" report. He starts by pointing out the importance of the approach made by League to economic problems *via* standard of living, for the League Assembly's resolution in this matter adopted in October '37 begins by recognising "that technical progress in industry, agriculture and transport has made possible further advances in human welfare." The great depression was responsible for fostering a sense of insecurity which made the problem of maintaining the volume of unemployment, *regardless of the standard of life*, the "supreme pre occupation" of most of the Governments of the world. It is high time, therefore, that balance is restored in the economic life and people should have the benefit of "one of the most powerful forces that is at work in human society: the instinctive desires of the individual to better his lot and to hand on to succeeding generations opportunities for an enriched life greater than those which he has himself inherited." One is tempted, however, to put the question if a substantial and sustained rise in the standard of living can be brought about in a capitalist society, beyond the point where it is at least apparently profitable to the employer to allow an increase in income to the workers.

A recent menace to the standard of life has come from the present state of political tension leading to "feverish rearmament", leading to a severe check to progress in the production of these goods which people need to improve their standard of living. It goes without saying that studies of consumption deficiencies, formulation of governmental polities relating to production and standard of life, etc., will be ineffective and inoperative so long as the present situation lasts.

Case of Primitive Communities

The report has a section on the economic developement of primitive communities underlying which is the 'trusteeship' doctrine and exaggerated notions about the work done in India, and Africa to remove the threats of famine or to ameliorate the economic, public health, and mortality position. Yet, the writer's conclusions and programme are helpful, though they ignore the basic political and economic causes of the poverty in these areas. According to Mr Hall "chronic under consumption in these regions appears to arise from three main sources: first, certain cultural defects; secondly, faulty methods of farming; and thirdly, inadequate facilities for the transport and sale of surplus produce." An analysis of these sources follow with suggestions for action, in the course of which the work of Sriniketan at Ballabkpur comes in for appreciative notice. Closely following Mr Hall's argument that "the development of the internal economic structure of agricultural states will create conditions favourable to the re orientation of the policies of the industrial states in the direction required for improvements in their standards of living," is his thesis that the 'primitive' communities "are capable of providing an elastic fringe to the trade of the world as a whole which should have the effect of removing that pressure upon present markets which makes so many nations reluctant, if not unable, to remove existing restrictions." This thesis, however, is, to say the least, unacceptable to the people of these communities who aspire after a 'progressive, and industrial future. Mr Hall, of course, is not oblivious of this point of view, and as a top to it suggests a policy of "development of systems of multilateral trade under which the tropical peoples are encouraged to draw their imports from whatever quarter is most suitable to them, the metropolitan states obtaining the advantage of the increase in the general volume of international trade which would result from the increased purchasing power of these peoples." As a pious wish one would hardly quarrel with the sentiments expressed, but would naturally wonder when, if at all, a regime of customs-barrier-free regime in international trade would come. In fairness to Mr'Hall, it must be admitted that he has tried to formulate a re orientation of international trade policy which is like the rest of the memorandum, theoretically convincing.

B. N. C

* Preliminary Investigation into Measures of a National or International character for raising the Standard of Living (Memorandum prepared by Mr N. F. Hall), League of Nations, Geneva, June 1938.

NOTES AND NEWS

The Thermostat in the Human Body

At a session of the American Association of Anatomists Dr H. W. Magoun of the North western University Medical School, has announced the discovery of an organism near the centre of the brain which functions like a thermostat. When the body gets cold it starts shivering, which means that it is trying by muscular exercise to generate heat and counteract the cold. Perspiring is the reverse process for keeping the body cool. Dr Magoun has shown that curious results may be produced when the brain is stimulated at different regions of the skull with high-frequency or radio waves. It was in the course of such experiments that the existence of the cerebral heat equaliser was revealed. He showed that it was possible to cause cats and human beings to sweat under cold conditions or to chill and shiver in a heated room.

Effect of Clouds on Radiation from Sun and Sky

In the *Memoirs* of the India Meteorological Department vol. XXVI, part VIII, Mr P. K. Raman discusses the problems of solar radiation and its hourly and seasonal variations at Poona. In 1934 a Moll solarigraph has been set up in the Central Agricultural Meteorological Observatory at Poona for recording continuously the intensity of solar radiation. During the summer months of April and May the mean radiation received in gram calories per square centimetre per day is 784 and 785. In July it falls to 388 and rises to 600 in November. It falls again to 478 in December and then rises to its summer maximum. The hourly variation shows a sharp maximum at noon, which is very conspicuous in April and May.

High cirrus clouds do not affect materially the total radiation received on a horizontal surface. A veil of cirro-stratus decreases the intensity by about 10 and a thick cirro stratus by about 20%. Medium clouds cut off more of the incoming radiation and the radiation received may be 40 to 70% of that received on a clear day of the same month. Low clouds may cut off completely the solar radiation. That received is only the diffuse radiation.

Fluorene in Dyestuffs and Analytical Chemistry

The application of fluorene and its derivatives in dyestuffs and analytical chemistry formed the subject matter of a paper by G. Riveschl and F. E. Ray of Cincinnati University, which has been quoted in *The Chemical Age*, p 466, 1938. The structure of fluorene and the syntheses of the various derivatives of fluorene and fluorenone have been discussed in details. Dyestuffs prepared from this source have been various, some of which are substantive to cotton and some can be used to directly dye wool and silk. The preparations of tatrazoderivatives of 2,7 diaminofluorenone and of a series of azo dyes from 2 aminofluorinone by Sircar and Bhattacharya (*Jour. Ind. Chem. Soc. 8*, 637, 1931; *9*, 521, 1932) have been mentioned in this connection. Regarding the analytical uses of fluorene and its derivatives it has been shown that 2 to 3 drops of a 2% solution of fluorene in alcohol give distinctive colour reactions with suspensions or solutions of glucose, sucrose and arabinose in alcohol, in presence of H_2SO_4 (Conc.) and that the same colorimetric test can be used for the detection of traces of aldehydes. The use of 2, 7-diaminofluorene in the quantitative determination of zinc has also been mentioned.

Zoological Survey of India

The Report of the Director of the Zoological Survey of India for the years 1935 1938 gives the manifold activities of the Department for the period

under review. Owing to the retrenchment, the work of the department was curtailed and was mainly confined to the conservation and preservation of the very large collections which are of great importance for reference and study. The survey work relating to insect, mollusc and fish as well as on ethnology was carried on a limited scale, and special attention was paid to the study of ecology and biology of hill-stream fauna. Of the biological investigations, the Shell fisheries in the Andamans deserve special mention as of economic importance. Valuable data as to the habit, growth and longevity of the Shell fish *Trochus niloticus* were collected. This investigation was started in 1932 and was finished in 1935. In connection with the scheme financed by the Calcutta Corporation for finding out measures for preventing deterioration of the slow filter-beds at Pulta pumping station, an investigation as to the life cycles of the animals inhabiting these beds and their injurious effect on the filter-bed, has been in progress since 1936. The data obtained as to the invasion of the upper reaches of the river Hoogly by the estuarine and marine forms promise to be of great scientific interest. The working out of the animal and human remains from prehistoric sites at Harappa has thrown important light on the question of domestication of animals in India. The *Records of the Indian Museum*, and other publications made on the material collected by the Indian Museum continued to maintain their standard. Improvement is being made in the library which is constantly increasing. It is the largest zoological library in the East. The educative side of the museum was also not neglected and the report draws attention to the unsatisfactory condition of the public galleries. Some improvement was effected in this direction with the help of the grant of Rs. 8,000/ sanctioned by the Government of India. The additions of exhibits illustrating the life of sea anemones and aerial vision of fish, with English and Bengali titles, have made the galleries more attractive. With the re-arrangement of exhibits in the bird gallery and the installation of the habitat group of the Indian storks this gallery has continued to be popular with the visiting public. Much more however is still desired. The report justifiably draws serious attention to the unfortunate position of the qualified and trained assistants who had been doing valuable scientific work in the department and to the inadequacy of the number of the gallery assistants for the proper maintenance and improvement of the public galleries. The proposals laid down by the Director in his report for the efficient work in the department deserve careful and sympathetic consideration by the Government of India.

The Worker's Standard of Living

Anent the review-article entitled "Raising the standard of Living" it might interest our readers that the International Labour Office has recently issued a Report on "The Worker's standard of Living" of a preliminary character. An attempt has been made to clarify what is meant by "Standards of living." The Labour Office stresses on the one hand such objective elements of welfare as income, consumption, social services and working conditions, which are reasonable to a large extent; and on other, housing, clothing, health services and education for which it is difficult to establish "objective norms". The Report notes the paucity of data for a description and evaluation of worker's living standards. Even with such limited material, an attempt has been made to make a partial survey of actual levels of living in four countries the United States of America, Poland, India and Japan One of the general conclusions reached is that the level of family income and the size of the family are the chief determinants of the workers' standard of living. Emphasising the need for the study of better physical and social conditions and of methods of "ensuring a better distribution of the product", the report makes the cautionary recommendation "in view of the fact that in countries with a rapid rate of population growth, measures for the improvement of health and social conditions may result in an even more rapid rate of population increase and therefore in increased population pressure, it is of importance to pursue the study of problems of the 'optimum' population of each country and of questions connected with the most effective distribution of the world's population".

Sir Richard Arman Gregory

Sir Richard Gregory who has been so conspicuously editing the *Nature* for the last 20 years has retired and is now on a lecture tour in America on social relations of science. On this occasion the small number of men in India engaged in the active pursuit of scientific research, remember with gratitude the kindness and courtesy with which scientific publications from India have been treated in the columns of *Nature*. Some years ago, Sir Richard Gregory made a to

round India and came in active contact with Indian scientific men, and became acquainted with the needs of Science in India. He has on many occasions advocated through the editorial columns of *Nature* that the Indian Government should adopt a more enlightened policy towards scientific activities in India. But these pleadings have so far fallen on deaf ears. We hope that this will not deter Sir Richard and his colleagues of *Nature* to take a more active interest in Indian science. In India there are now two papers representing scientific opinion, *Science and Culture* published from Calcutta, and *Current Science* published from Bangalore. Readers of these journals will not fail to note that in India, science has still to win her proper place in society against religion, ignorance, and above all against political inertia, but we have a faith in the gospel of Science, and we believe that Science gives us ethical principles for the essential improvement of Man and Society.

Before concluding this we are tempted to reproduce for our readers the following appreciation of Sir Richard by F. F. Bunker of the Carnegie Institution of Washington in the December issue of the *Scientific Monthly*, to which we add our felicitations.

"Richard Arman Gregory was born in Bristol in 1864. His father was a shoemaker by trade, but a poet by nature and the author of several volumes of beautiful verse. His grandfather was for sixty years a lay preacher of Wesleyan Church at Bideford, Devon, where a tablet is erected to his memory. Sir Richard said on one occasion, "My grandfather preached the Gospel of Christ; my father preached the gospel of science; but the ethical principles of all three are the pursuit of truth and righteousness for the improvement of man and society."

After leaving school at twelve years of age, Sir Richard became in succession a newspaper boy, page boy, machine boy in a printing office and apprentice to the boot and shoe trade. Through his studies before and after factory hours, he came to the notice of the head master of Clifton College, on the outskirts of Bristol, and was given by him a minor post in the physical laboratory of the college.

After leaving the college, he became science instructor at H. M. Dockyard School, Portsmouth, but returned two years later to become research assistant to the great astronomer, Sir Norman Lockyer, who in 1868 discovered in the sun the then unknown gas, named by him helium, which was not identified on the earth until twenty-six years later. In 1893 Sir Richard became associated with Sir Norman as assistant editor of *Nature*, (founded by Lockyer in 1872) succeeding him as editor in 1919.

Sir Richard's early contacts with social reformers and with the stern realities of life and labour made him familiar with the human aspects of applied science as affecting industry. This probably accounts for the attention given in *Nature* during his editorship to the social relationship of science. He holds that as science is responsible for the industrial developments and economic changes which have caused violent disturbances in the social structure and provided also the means by which civilization may commit suicide, it has a duty to guide the human race to the wise use of the powers it has created.

In line with this conception of the place and purpose of science, Sir Richard declares that the day when men of science were expected to keep within the bounds of their laboratories and any attempt to enter social fields was resented as an intrusion is past. "Fifty years ago", he says, "science had to establish its rights to the pursuit of truth in matters affecting traditional belief, but to-day it is the state and not the church which would suppress intellectual freedom."

Because of his condemnation of actions which destroy this essential condition of progressive knowledge and of the persecution of scientific workers for racial reasons or because they are unwilling to be fettered by political chains, several months ago the minister of education in Germany issued an order that *Nature* should not be taken officially in the universities and public libraries of that country."

Professor Arnold Sommerfeld

The seventieth birthday of Professor Arnold Sommerfeld of the University of Munich was celebrated on the 5th of December last. Dr Sommerfeld was born at Königsberg, Germany. He studied mathematics and natural sciences at that university, and in 1891, he received his doctorate degree. Four years later he came under the influence of Felix Klein, one of the strongest personalities in mathematical physics at the time. In 1900 he became the professor of mechanics

at the Institute of Technology of Aachen. After six years he was appointed head of the department of theoretical physics of the University of Munich, one of the most important positions in Europe. Since then Munich has become the starting ground of most of the younger theoretical physicists of repute. Professor Sommerfeld is best known for his researches in the sphere of atomic structure. Dr Sommerfeld generalized the Bohr-Theory of the hydrogen atom by introducing elliptic orbits and of the four quantum numbers which characterise the electron, three *viz.*, the azimuthal, the radial and the inner quantum numbers are due to Sommerfeld and his school. That he is just as active as ever is evidenced by the fact that *Science Abstracts* lists sixty of his papers in the last twenty years. He has an entirely independent reputation in several fields of applied physics in addition. In 1909 he published a fundamental paper on the propagation of radio-waves on the earth, a paper which had enormous influence on the research in that field. In 1904 he published an epoch making paper on the hydrodynamical theory of lubrication. He continued work on this field and published a paper on the subject only a few years ago. His pupils, among others, Hopf and Heisenberg have extended his work on the stability of laminar flow in tubes and pipes, applying the method of small oscillations to the equations of hydrodynamics. There is also a long and beautiful paper on the breaking loads of beams. Among Professor Sommerfeld's pupils we can count most of the renowned mathematical physicists of our days, *viz.*, Pauling, Houston, Rubinowicz, Brillouin, Laporte, Pierls, Wentzel, Pauli, Green, Condon, London, Hertzfeld, Teller, Bethe, Heitler, Eckart, Lande, Morse, Rubenstein, Stuckelberg, Froehlich Ewald, Heisenberg, Debye and N. R. Sen. It may be remembered that Dr Sommerfeld paid a visit to India in 1928 and delivered a course of lectures on wavemechanics at Calcutta. Scientists all over India join in wishing him many more happy years of continued active work.

Sir Jagadish and the Bose Institute

Delivering his presidential address at the first Sir Jagadish Chandra Bose memorial lecture Sir Nilratan Sircar after tracing how Sir Jagadish was unconsciously led into the border region of Physics and Physiology described the gloomy periods (1901-14) in Sir Jagadish's life which later produced some of the wonderful machines to support his conclusions, of which the striking are Oscillating Recorder for recording the exceedingly feeble pulsations, Compound Lever Crescograph for measuring linear growth measurements showing a magnification of 5000 times which was further intensified in Magnetic Crescograph and Photosynthetic Recorder for certain sap movement experiments and the Diametric Contraction apparatus which can show diametric expansion and contraction in plants under the effects of heat or cold, poison or stimulants. He proceeded to narrate the growth of the Bose Institute and said that from the very start of his scientific career Bose was deeply struck by the peculiar constitution of the Indian mind which could always turn away from the scientific study of Nature to metaphysical speculations. But when the capacity of enquiry and accurate observation had been assured to be present, there were no opportunities for its employment, as there were no well equipped laboratories or skilled mechanicians and so when the earliest opportunity came to him in the shape of an acquisition of a considerable sum, as retrospective pay, he immediately determined to relieve the nation from this humiliating situation. But a more substantial gift to the nation lies in the self-confidence he has created in the Indian mind in the field of scientific investigations.

In this connection Rabindra Nath Tagore in his Memorial lecture observed very pithily "Victory is the inalienable claim of all genuine power having the might of attraction that naturally exploits all kindred elements on its path and moulds them into an image of glory. And such an image is this Institute, which represents the Master's life-long endeavour taking a permanent shape in the form of a centre for the inspiration of similar endeavours."

In offering his salutation to the illustrious founder of this Institute, humbly sitting by those (he could not come from Santiniketan) "who are deprived of a sufficiency of that knowledge which only can save them from the desolating menace of scientific devilry and from the continual drainage of the resources of life," he appealed to the Institute to bring our call to science herself to rescue the world from the clutches of the marauders who betray her noble mission into an unmitigated savagery.*

* A report of the work of the Bose Institute will appear in a subsequent issue.

SCIENCE IN INDUSTRY

Indian Vegetable Oils as Engine Fuels

As India is extremely poor in her sources of mineral fuels, a systematic search should be made for substitute fuels for engines. In this connection the report of the work done at the Industrial Research Laboratory of the Government Test House, Alipore, on Indian vegetable oils as fuels deserves attention. From the '*Abstracts*' of the paper on the "Use of Vegetable Oils as Fuels for Internal Combustion Engines" published by the Indian Science Congress, 1939, we find that as many as eight oils, *viz.*, Groundnut, Karanj, Punnal, Polang, Castor, Kapok, Mahua, and Cotton-seed, have been tried in a 8 H.P. Diesel Engine running at 1200 R.P.M. It has been found that some of these oils behave as satisfactorily as the high speed mineral diesel oil as regards startablity, power output, smoothness of operation and overall thermal efficiency, although pitting of the exhaust valve seat and the cylinder head was noticed after prolonged runs with some oils having a high acid value. Further work on other Indian vegetable oils is in progress.

Cotton Improvement in Karnatak

Kumta and Dharwar-American cottons, locally called Jawari and Villayati, used to be the two main varieties of cotton grown in Karnatak occupying an area of thirteen lakhs and two lakhs acres respectively. Kumta cotton gins 25 to 26 per cent. and possesses a staple of 7/8″. It is susceptible to wilt. Dharwar-American gins 28 per cent. and possesses a staple of ¾″. The Agricultural Department of the Bombay Government have now recommended, with a view to securing more profit to the cotton growers, the strains, Jayawant and Gadag No. 1 for the Kumta and Dharwar-American areas respectively. Jayawant is a cross between two pure strains Dharwar No. 1 and Dharwar No. 2 selected from local Kumta, and Gadag No. 1, locally called Upland, is a pure selection in Dharwar-American cotton. Jayawant gins 27 to 29 per cent. and has 15/16″ to 1″ staple. It resists wilt remarkably under field conditions. Gadag No. 1 cotton gins 32 to 33 per cent. and has 7/8″ staple. Taking 200 lbs. of seed cotton as the average yield of Jayawant per acre and 150 lbs. that of Gadag No. 1 the extra profits to the cultivators at the present low market rates are estimated at Rs. 2/- to Rs. 2/8/- per acre respectively. The total estimates extra profits to the cultivators per annum from the introduction and extension of these two improved varieties in the Karnatak is, therefore, well over Rs. 12 lakhs.

Petroleum in India

The production of petroleum in India (including Burma), according to the Geological Survey of India, is 350,322,222 gallons in 1937, the highest figure in the history of the industry. The amount of gasolene produced from natural gas was 10,616,313 gallons in Burma and 456,780 gallons in the Punjab.

The Yenangyaung field is one of the most wonderful oilfields in the world. At the end of 1937 there were 2,910 wells producing in the field. Besides a large number of wells drilled to shallow sands, this total includes 180 hand-dug wells, whose continued existence is one of the interesting features of the field.

In spite of this petroleum output in 1937 India contributed only 0.50 per cent to the world's production of petroleum during the year; of this 0.50 per cent, again, 0.40 per cent came from Burma and 0.10 per cent from India proper. The contributions from some of the other important petroleum producing countries were as follows: U. S. A 62.7 per cent, Russia 9.9 per cent, Venezuela 9.2 per cent, Iran 3.8 per cent, Netherland Indies 2.6 per cent, and Romania 2.5 per cent. But it should be noted that

new sites for more wells are being developed and further prospecting of wells is under hand. These conditions show the urgent necessity of an expert enquiry into the fuel problems of the country.

A Transportable Impulse Voltage Generator

For the purpose of examining parts of high tension mains with regard to their resistance to overvoltages that may occur when they are struck by lighting, they are subjected to a very high voltage impulse of short duration, which imitates as well as possible the conditions existing during an atmospheric discharge. The Philips Works announce that they have succeeded in designing an apparatus for more than one million volts impulse voltage in such a way that it can be placed on an ordinary trailer. This has made it possible to transport an appartus of this kind by road at a normal speed and to put it into operation at any place where an examination is to be made. This first really transportable impulse generator is now temporarily with Messrs. Willem Smith & Co's Transformer Works at Nimeguen for impulse voltage tests.

Shellac Research

At a meeting organised by the Burrough Polytechnic, London, as reported in *The Chemical Age*, p. 467, 1938, Mr A. J. Gibson, Controller of the London Lac Research Bureau, mentioned that 60,000 to 70,000 tons of sticklac, produced annually from 8.5 million-million female lac insects, yield seedlac and shellac to the amount of 35,000 tons worth about £2,000,000. Approximately 95% of this is the product of British India and the remainder is supplied by Siam, Singapore and French Indo China.

Dealing with the recent investigations on shellac, Dr R. Bhattacharya stated that modern researches on lac is concentrated to overcome the disadvantages namely its low resistance to water absorption and weathering, low softening range and slow and uncertain thermo-setting properties. By extraction of shellac with toluene, trichlorethylene and acetone fractions have been obtained which are superior to the original substance regarding softening point, water resistibility and film formation. Treatment of shellac with hot alcoholic potash also yields an insoluble residue which has properties similar to the fractions obtained by solvent extraction. In the quest to find further uses of shellac in industry an apparatus has been devised by means of which shellac in powdered form can be sprayed through a flame on porcelain, metal and wood surfaces. Attempts are being made at present to obtain thinner coating with sufficient flexibility. Improvement of the technique in this direction, if successful, may result in the replacement of solvents in lacquers.

Researches of a fundamental nature on this subject are, however, still meagre and the knowledge of the chemical composition of shellac is yet incomplete. According to Dr Bhattacharya, though the molecules of shellac are dynamic, the whole shellac may be looked upon as an isogel. There are several hydroxyl groups in each molecule and these are present in three dimensional network and " act as centres of interlinks between the chains providing special cross linkages which are necessary for hardening and gelling."

There are at present three institutions carrying on researches on lac. The Indian Lac Research Institute was established in 1925, the London branch was founded in 1933 and the branch at New York in 1934. These work in collaboration with each other. In addition to general research work, the London and New York branches also direct their activities to find further industrial uses for lac and to deal with trade enquiries. To meet the expenses incurred at these research bureaus a small excise duty has been levied on all exports of lac from India and the sum thus realised amounts to £20,000 to £25,000 a year.

B. K. M.

Position of Manganese in India

The present chief sources of production of manganese ore are Russia, India, the Gold Coast, South Africa, Brazil, Cuba, Egypt, Czechoslovakia, and Japan. The United Kingdom is still the chief importer of Indian Manganese ore. There has been a growing competition from outside India, notably from Russia, which is a source of danger to the manganese miners who should look forward for profitable use of the ore in other ways and also aim at more scientific mining and marketing.

The price of manganese ore dropped from 1924 to 1932 and it may be correlated with the fact that from 1924 to 1927 the rate of increase of the world's production of manganese ore was much greater than the rate of increase in the world's production of pig-iron and steel. And although there was a fall in the world's output of manganese ore in 1928, there was very large increase in 1929, greater than was justified

by the increased production of iron and steel in that year, and it is evident that the world's available supplies of manganese ore are now much in excess of normal requirements. Russia is able to place large quantities of ore on the market at a price with which many Indian producers find themselves unable to compete. The Gold Coast has become a serious competitor of recent years. The large deposits of high-grade manganese ore discovered near Postmasburg in South Africa are also being developed.

There is however a steady increase in consumption of managenese ore at the works of the two principal Indian iron and steel companies, not only for use in the steel furnaces of the Tata Iron and Steel Company, and for the manufacture of ferro-manganese, but also for addition to the blast-furnace charge in the manufacture of pig-iron.

India's Iron Output

According to the latest report of the Geological Survey of India, India is still the second largest producer of iron in the Empire and yields place only to the United Kingdom. Her output of iron ore was about three million tons in 1937, of pig iron about 1.6 million tons. The export shows a fall, Japan still remaining the principal consumer of Indian iron with 47.2%, of the total exports, the United Kingdom following with 36.1%. The export value per ton of pig iron rose from Rs. 22.6 in 1936 to Rs. 34.5 in 1937. The steel industry is still protested to a certain extent by the varying tariffs on different classes of imported

The Nutritional Value of Ghee and its Industrial Possibilities in Bengal*

Sailendra Mohan Das Gupta
Department of Chemistry, Medical College, Calcutta.

Nutritional Value of Ghee

From time immemorial, *ghee* (clarified butter fat) plays an important role in our everyday life. To the Hindus, it is considered to be a sacred thing, being an important item in all religious performances. In fact, it is the most easily digestible and appetising fat and the Indians seem to have an instinctive demand for this particular fat. During the last Great War, when there was a great shortage of edible fats, the soldiers felt a natural desire for them and there was a general demand for fats. Whilst the European and other foreign soldiers were satisfied with various kinds of fats, the Indians felt the necessity of ghee or clarified butter fat. It is now a well-known fact, that ghee is the chief source of vitamin-A among the various food materials consumed in India. This food factor is vitally necessary for the people of Bengal where mal- and subnutrition due to the lack of this vitamin is very high, only next to the province of Madras. The influence of butter on the growth and nutrition of growing children will be evident from the following feeding experiments by Dr H. C. Carrieman in England. 61 school boys were given the usual daily diet and it was found that they gained an average of 3.85 lb. per boy and grew an average of 1.84 inches per boy during 12 months. Of them, 26 boys were given 1¾ oz. of New Zealand butter daily in addition to the usual diet. Now they gained an average of 6.30 lb. per boy and grew an average of 2.22 inches during the 12 months. These experiments clearly illustrate the necessity of butter or rather vitamin-A present in it for the growing children. Recent experiments have shown that continued deprivation of vitamin-A from the diet causes retardation of growth, greatly increased liability to infections particularly of the respiratory and genito-urinary tracts and susceptibility to curious disorders of the eyes to which the names of "Xerophthalmia" and "Keratomalacia" have been given.

* Read at a meeting of the Biochemical Society, Calcutta, in the All-India Institute of Hygiene and Public Health.

SCIENCE IN INDUSTRY

Vitamin-A Content of Butter

To be free from the deficiency diseases mentioned above, an adult requires about 1000 International Units of vitamin-A per day through his daily diet. An accurate estimate of the quantity of ghee supplying this necessary amount of vitamin-A cannot, however, be even approximately made, for the vitamin-A content of butter is different in different parts of the world and moreover, the vitamin content of butter of the same place undergoes wide variations. Thus British butter has been found to contain 26-200 International Units of vitamin-A per graume of butter, whilst for American butter, the value lies between 17-50 International Units. The variability of vitamin in butter or milk from which the butter is made will be seen from the following experiments. Hopkins in England observed growth in rats on a synthetic diet by adding 2 c.c. of milk daily. Whilst Osborne and Mendel in America working with a similar diet were unable to obtain successful growth even when 16 c.c. of milk were given. This will clearly show that the vitamin content of the two milks must have been widely different and the milk used by Hopkins contained 8 times more vitamin than the milk used by Osborne and Mendel in their experiments. In India, butter is usually consumed in the form of ghee or clarified butter and during clarification much of the vitamin is no doubt lost. The value for ghee is, therefore, much less and has been found to contain on the average only 10 International Units. The Bazar samples which are generally remelted or adulterated have found to be completely devoid of vitamin-A by many workers. Good samples of Bengal ghee have been found to contain 10-15 International Units and are therefore in no way inferior to butter made in other provinces so far as vitamin content is concerned. A few samples of Bengal ghee have been found to contain as high as 50 International Units.

Daily Requirement of Ghee

Assuming that the best sample of ghee produced in Bengal contains 50 International Units per gramme of the fat, then a daily intake of about ½ oz or about ½ seer of ghee per head per month can supply the necessary amount of vitamin. But as stated above, the average value is much less and particularly the Bazar samples are almost devoid of vitamin-A. Moreover, the vitamin content of ghee depends on the amount of green fodder supplied to the cows from which the ghee has been made. The ghee made from a cow on green grass contains many times more vitamin-A than the ghee made from a cow fed up on paddy straw alone. This is very important fact and clearly demonstrates that it is the quality and not the quantity that counts so far as the nutritional value of milk is concerned. This is a subject which is unknown to most of the educated people and medical practitioners. They think that drinking milk or taking butter alone can supply the necessary vitamin but this is not always the case for the milk or ghee consumed may not contain any vitamin at all.

Consumption of Butter

From the above, it will be seen that the vitamin content of ghee produced in Bengal and other parts of India are much less than those produced in other parts of the world. The consumption of ghee per head is still less. Thus the *per capita* consumption of ghee in India is less than 1/8 lb. per month, whilst the average percapita consumption of butter per month in the United Kingdom is about 2 lbs, for Australia it is 2½lbs and for New-Zealand it is 3¼ lbs. Thus so far as vitamin content is concerned, the quality of ghee is much inferior and the percapita consumption is a very low figure. This is a subject which should attract the attention of the Agricultural and Public Health departments of the Government and researches should atonce be started so that the quality and quantity of ghee are both raised to satisfactory levels, if the country is to be saved from the ravages of deficiency disease.

Green Vegetables and Ghee

The above literature might lead the readers to the conclusion that milk, butter and ghee are perhaps the only source of vitamin-A. There is another great source, namely, the green vegetables. Here, however the vitamin is not present as such but in the form of a yellow pigment named Carotene which remains masked under the green coating of chlorophyll in all green vegetables. It may be noted here that the yellow colour of the carrot or the yellow colour of fresh milk or butter is due to carotene. It has now been isolated in the pure state and is a yellow solid, insoluble in

water but soluble in fats and organic solvents such as ether, chloroform etc. Because of its solubility in fats, it is known as a fat soluble pigment. Recent experiments have shown that this yellow pigment, carotene can be converted into vitamin-A by many animal tissues *e.g.*, the liver of the cows, goat, sheep, buffalo etc. That is how vitamin-A is found in milk or butter, for carotene which is present in grass in large amounts is converted into vitamin-A in the liver of the cow and excreted through milk. In fact it has been found that the more grass is given to cows, the greater is the vitamin content of the milk. The conversion of carotene into vitamin-A is not, however, in the least quantitative and only a small fraction of it is converted into vitamin-A by the animal tissues. How far this is true in the case of man is yet obscure although experimental evidences are forthcoming in favour of this possible transformation. Absorption experiments in the human subject have shown that on a typical Bengali diet, carotene as present in green vegetables is fairly absorbed provided sufficient fat is also present in the diet. Assuming, however, that 50% of the carotene present in the cooked vegetables are absorbed by man and 5% of this absorbed carotene is converted into vitamin A and the average Bengal *Sâk e.g.*, spinch contais about 4 mg. of carotene per 100 gramme of the fresh vegetables, then the daily amount of *sâk* that will be necessary to supply 1000 International Units of vitamin-A will be about 30 ozs or about one seer per day per man. The average intake is much smaller than this, about 4 ozs per head per day. Moreover, the actual conversion of carotene into vitamin-A is much smaller than this and much of the carotene is also lost by bad methods of cooking, storage etc. Moreover, a certain fraction of the carotene is also lost during its passage through the alimentary tract. In any case, however, it is evident that what is obtained from ½ ounce of ghee will require about one seer of green *sâk* which is too above the average figure of only 4 oz per head day. Further, ghee is a fat of high calorific value. From all considerations, therefore good samples of ghee are more efficient than the green vegetables so far as human nutrition is concerned.

Green Fodder and Vitamin-A Content of Butter

In the previous paragraphs, it has been mentioned that the vitamin content of butter depends on the green fodder of the cow. This will be clearly seen from the following experiments carried out by the author with butter-fats produced in Vikrampur in Dacca which is a well known butter producing centre of Bengal. During the autumn (average temperature 86° F), the cows of Vikrampur mainly live upon paddy straw (as almost all the grazing fields are under water during this part of the year) and during winter (average temperature 72° F), the cows are fed with fresh green fodder or grass *e.g.*, *Kâlai Sak* containing on the average 6.6 mg. of carotene per 100 gramme of the green fodder. It has been found that the vitamin content of butter on the paddy straw ration (which contains only a negligible amount of carotene) is much less than the butter produced during the winter. From these researches it will be evident that the cows should get an ample supply of green grass, from which the cows of Bengal are generally deprived of. The cattle census report of 1915 states that the land available for grazing was so overcrowded that as many as 69 animals struggled for existence in one acre of grazing field in some parts of Bengal. In fact the staple fodder in Bengal is the paddy straw which contains a negligible amount of carotene. This is the cause why the milk and ghee produced in Bengal are so lacking in vitamin contents. This is particularly to be seen in milk from city cows which rarely get green grass. This is a matter which should immediately be taken up by municipal corporations and the Public Health Departments. Further the present indigenous method of making ghee in Bengal is very old which consists in clarifying crude butter made by churning *dâhi* at about 150° C for four hours in almost open vessels. Such process is highly destructive to vitamins. New methods should therefore, be devised so that the vitamins content of ghee remains intact. Bad method of storage is another way for the loss of vitamin. This point should also be duly considered along with the former.

Industrial Possibilities of Ghee in Bengal

From above, it will be seen that ghee has a great nutritional value in India and is the chief source of vitamin A which is so essential for the growing children and for resistivity against diseases like tuberculosis etc. It has immense industrial possibilities in Bengal. Bengal has a cattle population of over 25 millions, the second highest provincial total in India. As to milk supply which is so indispensible for the health of the population, Bengal possesses over 8½ millions cows. But the supply is so poor that it hardly exceeds

½ chataks (3 ounces) per head per day. The amount of ghee produced in Bengal cannot be definitely stated. The production is not carried out on a manufacturing scale as Bengal ghee is rarely exported. Ghee has a great demand outside and ghee worth 50 lacs of rupees are annually exported from Calcutta. But the ghee produced in Bengal cannot stand in competition with the ghee produced in other provinces for two reasons: firstly, the ghee made in other provinces are freely adulterated with buffalo ghee, vegetable fats, lard, tallow etc. The price of ghee can, therefore, be kept at a much lower level. Although the price is thus cheapened, the nutritional value is much lowered as during such adulteration processes that vitamin is totally destroyed, secondly, the present Adulteration Act does not make any difference between the various kinds of fats and it relies on certain values *e.g.*, Reichert value. This value has been kept at a minimum standard of 2.4 (Notification No. 4. P. H., dated the 5th January, 1922, under section 20 of the Act issued by the Government of Bengal). Now Buffalo ghee has a value much higher than this standard of 24 and therefore can be freely mixed with cow's ghee. The number of buffaloes in Bengal is very small in comparison with other provinces and consequently the Bengal ghee is usually pure cow's ghee. The present Adulteration Act cannot, therefore, help the genuine producers of cow's ghee in Bengal and on account of the import of freely adulterated products from other provinces, Bengal's genuine products are not patronised by the public. In the interest of the dairymen of Bengal therefore, the Act should be so ammended in the light of recent researches that the Act substantially helps the dairymen of Bengal instead of ruining the industry as what is actually happenning.

It is therefore, suggested that vigorous propaganda should at once be started to discourage adulteration of ghee of any sort which, as has been stated above, is, the main cause of the destruction of vitamins and therefore highly injurious to health. People should also be advised to consume more cow's ghee particularly in cities and towns where men are more liable to deficiency diseases. This will serve a twofold purpose: (1) Saving the people from many wasting diseases *e.g.*, tuberculosis and (2) reviving a home industry which if centralised and properly controlled may prove one day to be a national industry of Bengal.

Experimental Dairy Farms

In modern times, all civilised countries of Europe and America made elaborate arrangements to organise, control and regularly supervise dairy industries. So far as India is concerned it is a hopeless state of affairs, there being absolutely no control over the supply of milk and butter. As a beginning experimental dairy farms should be at once started in the various districts of Bengal under the control and management of the Government whose aim will be to improve both the quality and quantity of milk and butter under the prevalent conditions. Here researches should also be carried on to improve the present indigenous methods of preparing ghee, its preservation etc. Such experimental stations will no doubt inspire others in this field and thus solve the unemployment problem to some extent.

Medicine and Public Health

Medical Relief in Bombay

The first experiments with subsidised private medical practitioners having proved successful, the Government of Bombay has decided to open 200 new centres in the Province and to put them in charge of such practitioners in Allopathic, Ayurvedic and Unani systems of medicine. The annual grant for medicine to the first will be Rs. 350/- per annum and Rs. 150/- to each of the latter two. They will also get Rs. 30/- as monthly subsidy and a travelling allowance of Rs. 15/- per month.

The Government will contribute to four fifths of the cost of maintaining four nurse-midwives in each district, who will be attached to the District Local Board dispensaries. The total number of such appointments will be 76.

Six tuberculosis clinics have been opened in 1937 and three more are under contemplation. Free microscopic examination of sputa is also being considered. Civil surgeons and the Medical Officers under them in the districts have been instructed to take up the treatment of leprosy at their respective institutions.

The International Training Course for the Medical Practitioners

The Academie of Berlin has arranged a course of lectures for German and foreign medical practitioners. The course will begin after the middle of February and continue up to the middle of May, 1939. The programme includes lectures on the following subjects: (*i*) The importance of early symptoms in the prevention and treatment of diseases with special reference to the working population (*ii*) Lectures on functional Pathology and treatment (*iii*) Lecturers on Pathology with special reference to diseases in individuals (*iv*) Lectures on chronic diseases caused by the working life (*v*) Lectures on Surgery (*vi*) Course on Tuberculosis in the Tuberculosis Hospital of Berlin City (*vii*) Course on Ear, Nose and Throat diseases (*viii*) Course on Homeopathy (*ix*) Special courses on any aspect of Medicine as desired.

Lectures could be had, if wanted, in English or French language. Detailed information may be gathered from the "Society of Berlin Academie for Medical Courses", Berlin N.W.7, Robert Koch, Platz 7, Phone 412414.

Foreign and German doctors living in foreign countries will get 60% off from the railway fare in Germany if they come for the course and the stay in Germany may be made cheap if the doctor uses "Register Mark".

XIth Conference of the International Union against Tuberculosis

The International Union against Tuberculosis which seeks to bring about useful collaboration between different countries in all questions of the battle against tuberculosis will meet in Berlin from 16th to 20th September, 1939. The President elect is Dr Otto Walter, Germany.

The subjects for discussion at the Berlin Conference are:

(*i*) the problem of the virulence of the tubercle bacillus,

(*ii*) the value of systematic examinations for the detection of tuberculosis in subjects over 15 years of age, and

(*iii*) the rehabilitation of the tuberculous.

The first subject will be opened by Dr Boquet of France and Dr A. Saenz of Uruguay, the second subject by Dr H. Braeuning of Germany and the third

subject by Sir Pendrill Varrier Jones (Great Britain) and Dr E. Bachmann (Switzerland). Dr A. C. Ukil, who is a Council Member from India, has been invited to participate in the conference.

Besides the scientific programme, the members will be conducted through wellknown tuberculosis institutions and other places of cultural interest in Germany and Austria.

The official languages of the conference are French, English, Italian and German. Addresses and Speeches in any one of these languages will be transmitted by a Siemens Interpreter Installation in the four languages and each participant will be able to hear the speech in the language most faimiliar to him.

Council Members and Ordinary Members do not need the payment of any fees, but other members intending to attend the conference, should apply through their national Governments or affiliated associations, for membership on payment of RM. 20 to Konferenz leitung der XI Konferenz der Internationalen Vereinigung Zur Bekämpfung der Tuberkulose, Berlin W 62, Einemstrasse 11, Germany, through the Commerz-und Privat-Bank, Depositenkasse HJ, Berlin.

The Indian Medical Profession

Major-General Sir Cuthbert Sprawson

Late Director-General, Indian Medical Service and President of the Medical Council of India,

The medical profession of India has peculiar origins, has peculiar conditions affecting it and would, therefore, require peculiar considerations for its future. Regarding the last objective it can at least be said how one should like the future of the profession to develop and to speak with one and influential voice on matters affecting the health of the Indian people.

The origin of the modern profession in India dates from the establishment by various provincial governments of medical schools and colleges to train Indian students by officers of the Indian Medical Service on the modern lines of the British Medical Schools. The senior medical college is only a little more than a hundred years old. It can now be concluded that the training was well done because of the present high standard attained by these colleges, by the fact that they are now able, in a large measure, to train their own teaching staff and by the success of their graduates in after life. One peculiarity of the profession in India is that there was formerly a preponderance of officers of Government among the leading practitioners of medicine. But in recent years the independent practitioners have largely increased in numbers and before long this independent element will assume a preponderating influence in the profession.

Another peculiarity of the profession in India, which may be called as the disunity of the profession and wherein it differs from nearly all other countries, is the existence of two grades of medical practitioners—the graduates and the licentiates. The graduates get trained in medical colleges and can bear comparison with those of any country and the Licentiates are the students of lower basic education who get a shorter training in medical schools. It is almost impossible for a Licentiate to become a graduate. The distinction between the two classes is more like a caste distinction and separation is more compartmental and more emphatic. They enter the different grades of Government services on different rates of pay and with different functions and privileges and are registered differently in the register. They have different association as well. Of course this state of affairs developed according to the needs of the time. But it obviously gives rise not only to separation of the profession but to undesirable antogonism and unhealthy rivalry. A similar analogy can be seen in Russia where also two classes of medical practitioners exist—the graduates and the 'feldshers'—the latter probably are less well trained than the Indian Licentiates. The author believes that it will be for the good of the profession and therefore, for the good of India as a whole, when the

profession in India will be united to speak with one voice. As a remedy to this unhealthy state of affairs he proposes to raise gradually the standard of licentiate teaching until it approximates to that of the graduate and then the differences should disappear. In India there exist two other classes—though in small numbers – the 'apothecaries' and the military assistant surgeons. The diploma of apothecaries is no longer given and the new entrants to military assistant surgeons' course are compelled to do the full graduate course.

From a survey of 28 medical schools in India the author concluded that none of the schools entirely attains the required standard of teaching and suggested to improve their education and to make them more efficient. According to the author the Madras Government is perhaps the most advanced of the local governments in this respect as they have transformed their two medical schools into colleges. For professional unity he suggests the formation of local medical associations that admit all kinds of registered practitioners. He advocates the profession to be numerous enough. He cannot regard the present numbers as excessive because when in Great Britain there is one registered doctor to every 1,048 of population whereas in India there is one doctor to every 9,300 of the people. It is always desirable that medical attendance should be made as accessible as possible to all.

The author next raised the primary question whether India should consider it her duty to provide free medical attendance for all her sick poor. In Great Britain apart from all health insurance schemes, the Poor Law of England provides free attendance for all who cannot afford a doctor. In India there is professional crowding in the towns and cities but in the rural areas there is a demand for more medical men. Practitioners will not readily, even when junior or even when partially subsidized, go to practice in villages and the smallest towns. There are social disadvantages of rural life for an educated man and also the difficulty of educating the children properly in a village school. The method of subsidy seems to be the best to induce practitioners to work in villages. A living wage and free drugs are provided for one who will see at least 25 patients a day free of charge. The rest of the day he has to himself for private practice. The system works well enough in Madras Presidency where there are 500 such subsidized practitioners and there is no reason why it should not work in other parts.

The author compared India with Russia as regards the medical problem. In Russia there is now one doctor for 1,700 people; but this is considered insufficient; they aim at one doctor per 1,000 inhabitants. As a temporary expedient they are attempting at a mass production of doctors and once the numbers are up more attention will be paid to quality. There the young graduate or 'feldsher' was bound to go for the first year or sometimes for three years, where he was sent and thereafter he could go where he liked. He received a living wage and for undesirable places more pay would be given. The provincial governments of India are asked to consider the feasibility of similar concessions to subsidized practitioners in certain areas. This suggestion has never been undertaken with sufficient resolution by local governments in India; the only government that has progressed at all in this direction is that of Madras.

As the tendency in Great Britain now is more to a scheme of State aid some think that medical aid in India should better be extended to rural areas by increasing the number of more controlled wholetime government servants than by the use of a subsidy. But strict comparison between India and Britain is impossible in this respect. But the author is of opinion that as a first stage the scheme of independent or subsidized attendance must be adopted and a sort of health insurance may will be introduced.

The medical council of India comparable to the General Medical Council of Great Britain has been established about five years ago and has done a great deal in that time. This council has been instrumental in securing re-recognition of the degrees of Indian universities by the General Medical Council. All the medical colleges of British India except one are now so recognised. This council is responsible for directing the attention of the local government and Universities to defects which have been remedied and also for inducing them to spend more money on colleges and hospitals. The council is now negotiating for mutual recognition with dominions and foreign countries. The council is of great use to graduates who wish to study in Britain or elsewhere abroad; it is of no use to licentiates who rarely require to study abroad.

As a result of over-crowding of medical men in towns the keen competition amongst them is tending

to produce a low standard of ethics. As a general rule the older members of the profession are the worst in this respect. The standard of medical ethics in India, though not yet up to the standard of Britain, is getting better and better. But the author has full confidence that young Indian graduates of to-day will raise the ethical standard to the best of their ability and with a higher education the ethical standard of licentiates will also be improved.

The adoption of methods of cure is usually a necessary preliminary to gain confidence of the people before the introduction of measures for the prevention of epidemics of infectious diseases. The public health side of the profession in India is increasing in numbers and in influence and is well-trained to afford local governments and other bodies the advice and executive ability to carry out improvements in the cleanliness of towns and healthiness of the countryside.

The author concluded that the medical profession in India is a competent body containing many able physicians and surgeons, some with the highest qualifications obtainable; but it would be still more competent as a body were it not for the peculiar and the too widely separated divisions and for the too urban distribution of its members. Of the measures suggested by him the most important ones are to devote more attention to the medical schools and to enlarge the number of subsidized practitioners in rural areas and to introduce a similar system in parts where it has not hitherto been known. The author has great confidence in the future of the Indian Medical profession and in time it will not only fulfil all the functions that are demanded of it but will initiate many improvements in the health of the Indian people.*

*Adapted from an address read before the East Indian Association in London.

The Biggest Tree in the World

The biggest tree in the world is the general Sherman Tree (named after the hero of the American Civil War) in the General Grant, National Park, California. It belongs to the species Sequoia Gigantea, and its dimensions are as follows:—

Height above mean base	..	272.4 ft.
Basic Circumference ..	..	101.6 ft.
Greatest Base Diameter	..	36.5 ft.
Diameter 180 ft. above ground	..	14.0 ft.
Height of largest branch	..	130.0 ft.
Diameter of largest branch	..	6.8 ft.
TOTAL WEIGHT	..	4.3 million pounds.

The Sequoia Gigantea is exceeded in height by other species of the Sequoia, notably the Redwood tree, and the eucalyptus, which reach sometimes a height of 400 ft. But they are less voluminous, the diameter seldom exceeding 16 ft.

Nobody knows how long these trees may not live. One tree was felled which showed 3126 years by careful ring count. This tree was born nearly 1200 B.C., when Pharoah Ramses was ruling in Egypt, and probably sometimes before Troy was being destroyed by the Achaeans from Greece mainland. Experts estimate that provided sufficient protection be given, the trees may live up to 10,000 years.

Walter Fry and John R. White—Big Trees.

Research Notes

Nature of Glassy State

In a paper on "The Diffusion of Helium and Hydrogen through Pyrex Chemically Resistant glass" (*Jour. Chem. Phy. 6*, 612,1938) N. W. Taylor and W. Rast describe some interesting observations on the nature of the glassy state. They measured the rate of diffusion of helium at different temperatures between 180°C and 590°C and of hydrogen at 512°C through pyrex chemically resistant glass. Below 548°C the rates of diffusion increased by about 10% on heat treatment of the glass. Since the density of glass increases on heat treatment this result precludes the simple physical theory of porosity governing the diffusion process. It rather indicates a chemical theory of successive association and dissociation, which processes are accelerated when there is stable equilibrium in atomic arrangement ensured by sufficient heat treatment. Between the temperatures 440°C to 590°C, logarithm of the rate of diffusion R depends linearly on $1/T$. As this range extends into the region of a true viscous liquid, it is concluded that "the properties of a stabilised glass are continuous with those of a viscous liquid and that there is no need to postulate a separate glassy state." It is suggested that the transformation point usually observed in glass is due to strain in unannealed samples which is released at that temperature. Below 440°C the slope of log R versus $1/T$ curve decreases; this is explained as due to loss of rotational or vibrational freedom in the silicate complex.

K. B.

The Locomotion of the Earthworm

Professor J. Gray whose recent work on the locomotion of fishes has shed new light on that phenomenon has now studied the locomotion of the earthworm in collaboration with Mr H. W. Lissmann (Gray, J. and Lissmann, H. W.--Studies in Animal Locomotion, VII. Locomotory Reflexes in the Earthworm. (*Jour. Exp. Biol. 15*, 4, 1938). By means of cinematograph records he has found that forward progression begins by the contraction of circular muscles of the anterior segments, and that a wave of circular contraction passes over the body of the worm. When this wave has passed over the front half of the body, the circular muscles at the extreme anterior end of the body relax, and contraction of the longitudinal muscles begins. Now a wave of longitudinal contraction passes over the front half of the body and is followed by a second wave of circular contraction starting from the anterior end of the animal, and so on.

Each segment therefore moves forward, over the ground, in a series of steps, each of 2·3 cm. in length, at a speed equal to the length of one step multiplied by the frequency at which the locomotory waves pass over the body. Segments in a maximum state of longitudinal contraction form a "foot" or *point d'appui*, against which the anterior forwardly progressing segments exert a backward thrust equal to the frictional resistance generated by the movement of the extending segments over the substratum. At the same time, segments of the worm lying immediately posterior to the foot are undergoing longitudinal contraction and are exerting a backward pull on the foot equal to the frictional resistance of the posterior segments moving over the ground.

Gazaniaxanthin

Gazaniaxanthin, a new xanthophyll with one oxygen atom, has been isolated from the flowers

of *Gazania rigens* by K. Schön (*Biochem. J.*, *32*, 1566, 1938). Judging from its behaviour, this new compound is related to γ-carotene and rubixanthin.

Already three xanthophylls of the formula $C_{40}H_{56}O$ are known, of which cryptoxanthin is related to β-carotene, rubiaxanthin to γ-carotene, and lycoxanthin to lycopene.

Elementary analyses of gazaniaxanthin, obtained by chromatographic analysis of the saponified lipoid extracts of Gazania flowers, agree with the composition $C_{40}H_{54}O$ or $C_{40}H_{56}O$. It contains an alcoholic hydroxyl group, and crystallises from a mixture of benzene methyl alcohol (1:4) in brilliant rectangular leaflets of a deep red colour, containing methyl alcohol of crystallisation.

Further investigation to elucidate the chemical structure of gazaniaxanthin will be very interesting. Rubixanthin is known to be a derivative of γ-carotene containing a hydroxyl group in β ionone ring. Gazaniaxanthin may be an isomeride of this having the hydroxyl group in the aliphatic side chain, like lycoxanthin and lycophyll.

The correctness of this supposition can be tested by a biological assay, as a substance of the constitution proposed should be active as provitamin A.

H. N. B.

A New Growth Factor

It was previously observed, during experiments on the formulation of a diet for riboflavin assay with chicks, that middlings and yeast had a growth-promoting effect which could not be accounted for by their filtrate factor or diboflavin content. Almquist observed that a diet of polished rice, fish meal, dried yeast, salt, and cod liver oil gave better growth than a similar diet in which the yeast had been replaced by concentrates of riboflavin, filtrate factor, and thiamine.

Stokstad and Manning (*J. Biol. Chem.*, *125*, 687, 1938) report the results of their experiment planned to study this growth-stimulating factor in yeast and middlings. The results of their experiment indicate that the growth factor involved is distinct from any of the nutritional factors thus far described as being required by the chick. The authors also studied the distribution and chemical properties of the factor.

In all experiments white Leghorn chicks, in groups of ten to twelve, were used, being maintained in electrically heated batteries and given food and water *ad libitum*.

The authors conclude, from the experiments described in detail, that chicks require a dietary factor for growth not identical with vitamins A, D, K, thiamine, riboflavin, filtrate factor, vitamin B_4, and the antiencephalomalacea factor.

In large amount this growth factor is present in alfalfa, middlings, wheat bran, and yeast to a lesser extent in corn, and in very small amounts in polished rice.

It is insoluble in ether, acetone, and isopropanol but soluble in water and in mixtures of water and methanol. This factor can be adsorbed on fullers' earth and on activated charcoal, and can be eluriated from the fullers' earth adsorbate by a 1:1:4 mixture of pyridine, methanol and water.

The growth factor is not destroyed by autoclaving yeast while autoclaving alfalfa did destroy it. Refluxing in acid and in alkali media did not destroy the growth factor present in yeast extract.

H. N. B.

UNIVERSITY AND ACADEMY NEWS

Mining, Geological and Metallurgical Institute of India

(*Jamshedpur, 7th December, 1938*).

(1) Small scale manufacture of iron and steel in India by the direct method By P. N. Mathur.

(2) The iron-ores of the Bailadila Range, Bastar State— By H. Crookshank.

The National Academy of Sciences, India

(*Allahabad, 19th December, 1938*).

(1) Jupitor atmosphere. By A. C. Banerjee and Mohd. Nizamuddin.

(2) On the trematode genus Lyperosomum Looss, 1899, (Dicrocoeliidae) with a description of two new species from India.—By B. B. Pande.

(3) Two new species of Trematodes from *Anhinga melanogaster*.

(4) Changes in the viscosity of agar sol with temperature.—By S. N. Banerjee and S. Ghosh.

(5) Changes in the viscosity of agar sol with concentration. By S. N. Banerjee and Dr S. Ghosh.

(6) Constitution of Santalin. By Jagraj Bhehari Lal.

(7) Further studies of the F region at Allahabad.—By R. R. Bajpai and B. D. Pant.

(8) Migration of para halogen atom in a derivative of meta-cresol.—By A. B. Sen.

Royal Asiatic Society of Bengal

(*Calcutta, 2nd January, 1939*).

(1) Solstice days in vedic literature—By P. C. Sen-Gupta.

(2) Bhārata battle traditions By P. C. Sen Gupta.

(3) Madhu-Vidyā or the Science of Spring— By P. C. Sen Gupta.

(4) When Indra became Maghavān By P. C. Sen-Gupta.

(5) English tradition of Nimbārka's Commentary on the Brahmasūtras (Vedānta parijāta-Saurabha and Śrīnivāsa's Commentary on the same (Vedānta-Kaustubha) By Roma Chaudhuri.

(6) Mica with inclusions. (*Exhibited*)—By A. M. Heron.

(7) Manuscript of a Tantra Work on the cult of Pañcānana. (*Exhibited*)—By Chintaharan Chakravarti.

Indian Museum

The Trustees of the Indian Museum, Calcutta, have arranged a course of popular lectures on miscellaneous subjects, of which the following will be delivered this month at 5 30 p.m.

2nd Feb.	Cinchona Plant.	Mr S. N. Bal,
7th Feb.	Living Fossils.	Dr S. L. Hora,
9th Feb.	What is Art.	Prof. Sahid Subrawardy,
14th Feb.	Some food prawns and crabs of India.	Dr B. N. Chopra,
16th Feb.	The Radio and the Sun.	Prof. S. K. Mitra,
21st Feb.	Poisonous Plants of India.	Col. R. N. Chopra,
23rd Feb.	Islamic Architecture in India.	Mr Percy Brown,
28th Feb.	Probability of Existence of Life outside the Earth.	Prof. M. N. Saha.

LETTERS TO THE EDITOR

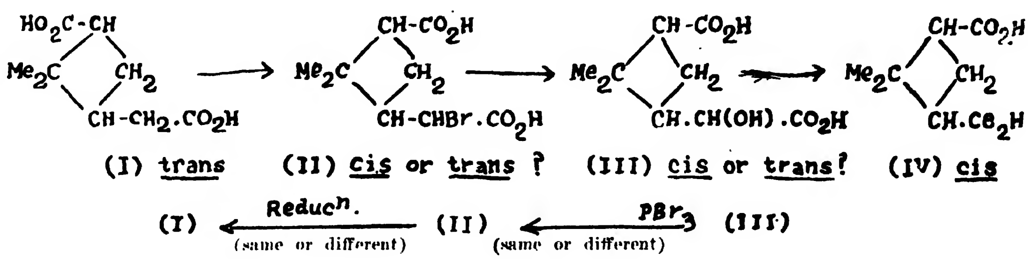
[*The Editor is not responsible for the views expressed in the Letters.*]

Configuration of Bromo- and Hydroxy-Pinic Acids.

Baeyer[1] and Perkin and Simonsen[2] obtained bromo and hydroxypinic acids from *dl*-α pinene by degradation and seem to have regarded all the acids (pinic, I; bromopinic, II; hydroxypinic, III; norpinic, (IV) as belonging to the *cis* series[3] on the ground that the final degradation product *viz.*, norpinic acid (IV) possessed a *cis* configuration. Guha and Ganapathi[4] however, have shown conclusively that the configuration of pinic acid obtained by the degradation of α pinene, as also the synthetic product obtained by them to be *trans*. They also expressed doubt about the *cis* configuration of hydroxypinic acid (III), as assumed by Perkin and Simonsen on the ground of its not passing over to the lactonic form.

In view of these apparent anomalies, it seemed desirable to ascertain the configurations of the two acids (II and III) and to elucidate exactly at what stage in the series of reactions (I to IV) the change of configuration from *trans* to *cis* actually occurs.

The actual configuration of bromopinic and hydroxypinic acids was sought to be determined by reproducing these acids from their immediate degradation products *viz.*, pinic acid from bromopinic acid and bromopinic acid from hydroxypinic acid, under experimental conditions not likely to cause any change in configurations and to compare the configurations of these products with the original ones (from identity or difference).



The results obtained, may be summarised as follows: (a) The bromo-acid (II) on reduction with zinc dust and acetic acid furnishes the same *trans*-pinic acid from which it is derived suggesting *trans* configuration for the bromo acid; (b) The hydroxy-pinic acid (III) on treatment with phosphorus tribromide gives back the identical bromopinic acid (II) of Perkin and Simonsen suggesting thereby that the hydroxypinic acid possesses the same *trans*-configuration.

As both bromopinic (II) and hydroxypinic (III) acids possess *trans*-configurations, as a natural sequel, the change from *trans* to *cis* configuration should have taken place in the final stage of oxidation of hydroxypinic acid to norpinic acid. The non-existence of a lactonic form of the hydroxypinic acid (III) is also now clear.

Department of Organic Chemistry,
Indian Institute of Science,
Bangalore. 7-12-38.

P. C. Guha.
P. L. Narasimha Rao.

[1] *Ber.*, *29*, 1907, 1896.
[2] *J. C. S.*, *95*, 1175, 1909.
[3] *loc cit.*, 1176.
[4] *Ber. 70*, 1505, 1937

Claisen Reaction with Thioketones

In view of considerable importance attached to β di-ketones as affording various types of reaction, it was thought a similar study on the corresponding sulphur analogues would be of interest.

The difficulty to meet this end was due to the want of a suitable method for effecting their synthesis. The meth-

of replacing oxygen with sulphur by the reaction of hydrogen sulphide with enolisable ketones[1] failed to furnish monomeric compounds. An extension of Claisen's reaction leading to the synthesis of thio-β-diketones could not also be effected uptil now due to any suitable method for the synthesis of unpolymerised thioketones not being available. The thioketones required have now been obtained in a good yield from the corresponding thioketonic acids and condensed with aliphatic and aromatic esters in presence of emulsified sodium to give rise to unpolymerised thio-β-diketones. Reactions characteristic to the activated methylene group in these compounds are being studied.

Chemical Laboratory,
University College of Science & Technology,
92, Upper Circular Road,
Calcutta, 15-12-1938.

N. K. Chakrabarty.
S. K. Mitra.

[1] Mitra, *Jour. Ind. Chem. Soc.*, 71, 1933; *ibid.*, *31*, 205, 1938.

Crystal Structure of Diphenylamine

Thin plate-like crystals of diphenylamine bounded by prism and pyramidal faces are obtained out of alcohol. On examination by Fuess and Czapski goniometers and on stereographic projection, the crystals are found to belong to the monoclinic holohedral class with the axial ratio $a : b : c = 1.01 : 1 : 2.78$ and $\beta = 91°\ 30'$.

X-ray measurements give $a_0 = 14.0$ Å; $b_0 = 13.9$ Å and $c_0 = 39.5$ Å whence the axial ratio is calculated as $1.01 : 1 : 2.84$ in close agreement with the goniometric value. The number of molecules comes out to be 32 per unit cell. A detailed report will shortly be published elsewhere.

Indian School of Mines,
Dhanbad, 10-12-1938.

J. T. Dhar.

The generalized interaction in a $S \times S \times S \times \ldots\ldots (= S^n)$ factorial design, where S is a prime or a power of a prime

When S is a prime or a power of prime, it is known that there exists a finite field, usually called a Galois Field, with just S elements, on which the four fundamental operations of algebra, obeying all the ordinary laws, can be performed. Associated to such a field, a finite geometry of any number of dimensions can be constructed, the co-ordinates of any finite point of which are elements of the field. Besides the finite points, we can, in the usual manner, adjoin elements at infinity, converting our affine geometry to a projective one.

We identify the S^n finite points in our n-dimensional projective geometry with the S^n treatment combinations in a $S \times S \times S \times \ldots\ldots\ldots\ldots$ factorial design with n sets of factors. It is easily seen that any parallel pencil of 'S' $(n-1)$—flats will partition the treatment combinations into S sets, the contrast between which represents $S-1$ degrees of freedom. It can be shown that the totality of S^n-1 degrees of freedom can be represented in this way by the contrasts appertaining to the $S^{n-2}+\ldots+S^2+S+1\ \{=(S^n-1)/(S-1)\}$ parallel pencils of our geometry. Those pencils whose vertices are the $(n-2)$- cells of the fundamental simplex in the $(n-1)$—flat at infinity yield the n sets of $S-1$ degrees of freedom corresponding to the main effects. Those pencils whose vertices are the $(n-2)$—flats at infinity passing through the $(n-3)$—cells of our simplex will represent the first order interactions. Through any $(n-3)$—cell, there pass just '$S-1$' $(n-2)$—flats at infinity which are not $(n-2)$—cells of the fundamental simplex. Each of these $(n-2)$—flats is the vertex of a pencil of $(n-1)$-flats corresponding to $S-1$ degrees of freedom belonging to a first order interaction. Thus we obtain in this way just ${}^nC_2$ sets of $(S-1)^2$ degrees of freedom corresponding to the totality of the first order interactions. In general, the k-th order interactions are represented by pencils of which the vertices are $(n-2)$—flats at infinity passing through the $(n-k-2)$ cells of the fundamental simplex, thus giving just ${}^nC_{k+1}$ sets of $(S-1)^{k+1}$ degrees of freedom. Finally, the highest order interaction is represented by pencils of which the vertices do not pass through any cell or vertex of the fundamental simplex.

Now, given any two pencils, each representing $S-1$ degrees of freedom, their vertices, each a $(n-2)$—flat at infinity, will have a common $(n-3)$— flat at infinity through which there pass $S-1$ other $(n-2)$—flat at infinity. The parallel pencils having these $S-1$ other flats as vertices will correspond to $(S-1)^2$ degrees of freedom which may be defined as the degrees of freedom corresponding to the generalized interaction of the two initial sets of $S-1$ degrees of freedom each. It can be shown that when $S=2$, Barnard's[1] definition of the generalized interaction in the case of a 2^n design tallies with the general definition given above. When any two sets of $S-1$ degrees of freedom have got to be confounded, the $(S-1)^2$ degrees of freedom corresponding to their generalized interaction are automatically confounded. It is, therefore, now as easy in the general case as in the case of a 2^n design to see what types of confounded designs are possible and to produce any of them directly and expeditiously.

We have fully investigated the various possibilities in the case of 3^n, 4^n and 5^n designs and constructed different types of balanced arrangements, confounding analogous sets of degrees of freedom. For greater details, we may refer to our paper on the subject to appear in a forthcoming issue of the *Sankhya*.

Statistical Laboratory,
Presidency College,
Calcutta, 20-12-38.

R. C. Bose.
K. Kishen.

[1] Barnard, M. M. An enumeration of the confounded arrangements in the $2 \times 2 \times 2 \ldots\ldots\ldots$ factorial designs. *Jour. Roy. Stat. Soc., Suppl.* 3, 195-202, 1936.

LETTERS TO THE EDITOR

The Application of Co-variance Technique to Field Experiments with Mixed-up Yields

When some plots of an agricultural field trial get damaged, Yates[1] has developed a method of estimating the missing values and of making *valid* tests of significance of treatment effects. Bartlett[2] found that Yates' results can be obtained by considering the problem as one of co-variance by introducing as many pseudo-variates as there are missing plots and assigning to each of them values 1 and 0 suitably.

A different type of problem arose in an experiment in India where yields of certain plots got mixed-up. The general problem faced is of k plots getting mixed-up, leaving a known total, say, u. P. C. Mahalanobis and S. S. Bose,[3] applying Yates' methods got estimates of the $k-1$ independent unknowns. I have found that this problem also yields to the technique of co-variance.

Introduce $k-1$ pseudo-variates $x_1, x_2, \ldots, x_{k-1}$ all having value 0 in the unaffected plots and the values shown in the following scheme for the k affected plots:

		x_1	x_2	x_{k-1}	y
Plot 1	..	1	1	1	u/k
„ 2	..	$1-k$	1	1	u/k
„ 3	..	1	$1-k$	1	u/k
..		..	..	..	..
..		..	..	..	..
..		..	..	..	..
..		..	..	..	..
..		..	..	..	..
„ k	.	1	1	$1-k$	u/k

The dependent variable, y, is given value u/k in each of the k affected plots and values of observed yields in the unaffected plots. Next, construct a multiple co-variance table. If $b_1, b_2, \ldots, b_{k-1}$ are the partial regression co-efficients of y on $x_1, x_2, \ldots, x_{k-1}$ calculated from the Error line, the adjusted values of y, namely

$$y - b_1x_1 - b_2x_2 - \ldots - b_{k-1}x_{k-1}$$

in the k affected plots supply the estimates of the individual yields of those plots. In the unaffected plots the adjusted y's will be seen to be the same as the observed y's. The *valid* measure of the treatment sum of squares can now be obtained by getting the adjusted sum of squares of y from the (Treatments+Error) lines and by subtracting from it that got from the Error line.

Statistical Laboratory,
Presidency College,
Calcutta, 20-12-1938.

K. Raghavan Nair.

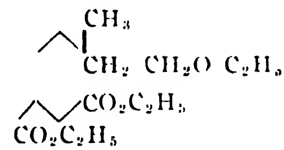
[1] Yates, F., *Emp. Jour. Exp. Agri.*, *1*, 129-142, 1933.

[2] Bartlett, M. S., *Suppt. J. R. S. S.* *4*, 137-170, 1937.

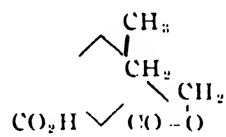
[3] Mahalanobis, P. C. and Bose, S. S., *Sankhyā*, *4*, (2), 103-120, 1938.

Synthetical Experiments in the Selinene Group

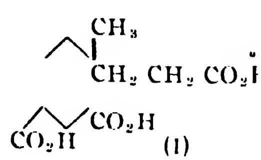
Experiments are being made with a view to find out a general method of synthesis in this group of sesquiterpenes. O-methyl cyclohexanone was condensed with β-ethoxy-ethyl iodide in presence of sodamide in ethereal solution to give 1-methyl-1-β-ethoxyethyl cyclohexan-2 one and 1-methyl-3-β ethoxy-ethyl-cyclohexan-2-one. 1-methyl-1-ethoxy-ethyl, cyclohexanone was purified from the 1:3-isomer by condensing with oxalic ester and the oxalo-derivative, on hydrolysis with baryta gave the pure ketone, (B. P. 99°/6.5 mm). This, on treatment with hydrocyanic acid gave the cyanhydrin (B. P. 147°/9mm) and this was dehydrated to the unsaturated nitrile with thionyl chloride and pyridine (B. P. 118°-20°/5 mm). The unsaturated nitrile condensed smoothly with oxalic ester in presence of potassium ethoxide. The oxalo-derivative was hydrolysed with alkali and was then oxidised with the calculated quantity of hydrogen peroxide. The unsaturated cyano-acid was reduced with sodium-amalgam and finally isolated as diethyl ester on digesting with alcohol and sulphuric acid. It boils at 187°-93°/7.5 mm.



This, on treatment with hydrochloric acid, is expected to give the following lactonic acid.



From considerations of the influence of the angular methyl group, there are reasons to believe that this lactone should have the *cis*-configuration, like that of the naturally occurring bodies. Conversion of this lactone into bromo ester by alcohol and hydro-bromic acid and to the cyano-ester by treatment with potassium cyanide and the subsequent hydrolysis to the tricarboxylic acid (1) are expected to follow the same course as in the case of Rydon[1] who prepared $\beta\beta$-dimethyl adipic acid starting from $\beta\beta$'-dimethyl valerolactone.



(1)

Selinic Acid

It may be added that on allowing the bromo-ester to react with sodiomalonic ester, it may be possible to build

s 9-methyl decalin systems with the appropriate substituents in both the rings necessary for the synthesis of naturally occurring sesquiterpenes.

The unsaturated nitrile obtained from O-methyl-cyclohexanone cyanhydrin condensed readily with oxalic ester in presence of sodium ethoxide to give 1-methyl-2-cyano-Δ^2-cyclohexenoyl formate m. p. 110°. This resisted thermal degradations upto 230°C and so it was hydrolysed and oxidised with hydrogen peroxide to give 1-methyl-Δ^2-cyclohexen-2: 4-dicarboxylic acid, m. p. 182°.

My grateful thanks are due to Prof. P. C. Mitter for his keen interest and advice during the course of this investigation.

Chemical Laboratory, P. C. Dutta.
University College of Science,
Calcutta. 10-1-39.

[1] *Jour. Chem. Soc.*, 1341, 1937.

SUPPLEMENT—Abstracts of the Sectional Presidential Addresses at the Lahore Session of the Indian Science Congress.

Physics and Mathematics

The Earth's Magnetism and the Upper Atmosphere

K. R. Ramanathan

The Presidential address to the Mathematics and Physics section of the Indian Science Congress contains a general survey of the problems of terrestrial magnetism, particularly of those which throw light on conditions in the upper atmosphere. After referring to the valuable contributions of the late Dr N. A. F. Moos to the science of terrestrial magnetism, the President said that the first definite contribution regarding the electrical properties of the upper atmosphere came from the study of earth's magnetism which is still providing a healthy check on theories regarding the upper atmosphere and continues to be suggestive of fresh problems for experimental and theoretical investigation.

Exactly a century ago, the great German mathematician Gauss in his work '*Allgemeine Theorie des Erdmagnetismus*, developed the spherical harmonic method of analysing the earth's field and thus laid the foundations of a scientific study of the origin of the field. He showed that practically the whole of the earth's permanent field was due to causes within the body of the earth, but did not overlook the possibility of a part, though a comparatively very small part of the magnetic force measured at the surface of the earth, proceeding from the upper regions. He remarked "We are forbidden to do so by the enigmatical phenomenon of the Aurora Borealis, in which there is every appearance that electricity in motion plays a principal part."

The so-called "permanent" field of the earth is itself undergoing a slow secular variation. Besides the well known change in the direction of the magnetic axis, the magnetic moment of the earth is slowly decreasing. Within the last century, the decrease has amounted to nearly 6 per cent. of its value.

There are also other variations of the earth's field, some regular and others irregular. The principal regular variations are the solar and lunar diurnal variations and their changes with season and solar activity, the annual variation and the eleven-year variation. Of the irregular variations or disturbances, the most conspicuous are the world-wide 'magnetic storms.' It is the study of these geomagnetic variations and of associated phenomena such as the auroras that have given most valuable knowledge about the upper atmosphere.

The solar diurnal variation of the magnetic field at any place on the earth is mainly a foundation of the geomagnetic latitude and of local time. On magnetically quiet days, the variation is much greater when the sun is above the horizon than when it is below; it is greater in summer than in winter and increases with sunspot activity. By the application of the method of spherical harmonic analysis to the diurnal variations of the earth's magnetic field, it has been established by Schuster and Chapman that both solar and diurnal variations have their main source outside the earth, but that associated with the external source, there is an internal part which produces about two-fifths of the effect of the external. There is evidence to show that this internal field is due to induced currents inside a conducting earth. If the external source of the solar diurnal variations is assumed to be a current system in the upper atmosphere, the nature of the current circuits can be worked out from the results of spherical harmonic analysis of the diurnal variations. It comes out that the current system on a magnetically quiet day consists of four closed circuits, two lying north of the equator and two south. Of the two circuits in each hemisphere, the one lying in the sunlit part of the earth is more intense than the other and the direction of the current in it is clockwise in the northern hemisphere with its focus at about 40°N. The current systems are symmetrical about the equator at the time of equinoxes, but at the solstices, they are more intense in the summer hemisphere and extend across the equator to the other hemisphere. The total current-flow in each day-time circuit at the time of equinoxes is about 60,000 amperes.

The location of the conducting layer is also a problem of importance. In the case of lunar diurnal variation, there is no question as to the cause of the movement of a conducting layer of the atmosphere. It

SCIENCE AND CULTURE

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India's Mineral Wealth

THE question of the conservation and proper utilization of India's mineral resources has been attracting the attention of the public for sometime. The vital and indispensable function which the mineral and metal industries of a country fulfil in its national economy cannot be overemphasised. Owing to extreme backwardness of India, the consumption of power per head per year and the consumption of metals in the country is abnormally low in comparison with other advanced European countries. If India is to raise her economic standard, both these will have to increase tremendously and attention must, therefore, be directed to properly organized scientific methods of extraction and utilization of fuel and other mineral resources of the country. Mineral resources of a country are not inexhaustible, and though India possesses minerals of practically all types, there are vast deposits of only a few, the sources of others being very limited. Due to unscientific methods of exploitation, coupled with lack of organization and proper development, colossal waste is taking place and the country is being deprived of enormous national wealth. It will not do to forget that India's resources of some very important minerals like coal are far too limited and a position seems to have already been reached when expediency and national interest demand that the question of conserving these and other metal resources of the country should be seriously tackled.

In his presidential address delivered before the Geology section of the Indian Science Congress, held in January last, Dr S. K. Roy sounds a timely note of warning and puts forward a strong plea for the proper conservation of India's mineral wealth. Dr Roy points out that within the last 25 years, the world has used more metal and more fuel than during the entire historical age. Minerals like coal and petroleum form the most important sources of power supply. Minerals also form important sources of raw materials for many chemical industries. Modern warfare to a very large extent depends on metals, nitrates, petroleum and coal tar derivatives. For national safety, as well as for the future growth and prosperity of the nation, we shall, therefore, have immediately to take up the question of planned economic exploitation of the mineral and metal resources in the country.

INDIA'S MINERAL WEALTH

In India there is a deplorable lack of knowledge about our mineral resources in things and in their possibilities. We have yet to know what we can do with them and what we should not do with them. The existing literature on the Indian minerals is utterly inadequate and no serious attempt is being made anywhere in India to teach mineral economics to our countrymen. Except for coal, we do not possess even the barest knowledge about the reserve and resources of minerals in the country. On the other hand, there being no restrictions ragarding the qualification of managers permitted to conduct the operation of metalliferous mines in India, there is nothing to guard against the huge waste of our minerals due to ignorance or carelessness of ruthless mine owners and mine managers. Private ownership resorting to unrestricted, careless and unsceintific method of working has long played havoc with the mineral deposits of the country and the time has come to serve them a reminder that " the owner's right to do as he pleases, to even squander national resources, cannot be tolerated indefinitely by society."

The question of conservation of fuel is really a vital one for our country. India has not been so liberally supplied by nature with high grade coal as she has been with other high grade ores. Our reserve of first class metallurgical coal is severely and according to Dr Roy's computation, if are allowed to go on as at present, there is the likelihood of its being exhausted in a very few decades. The Coal Mining Committee set up in 1937 worked out a somewhat longer life of these reserves but we cannot escape the conclusion that unless efficient substitutes for first class metallurgical coal are discovered and a vigorous policy of conservation pursued, the steel and other important metal industries in the country may have to close their doors in another 50 years. For the most economic exploitation of these reserves, special methods of working, which were not generally applied in the past, have got to be resorted to. Measures which increase safety of working in coal mines of course make for conservation to a certain extent It is not as well known as it ought to be that as a result of serious mining accidents and the huge fires in some of the important coalfields in the country, millions and millions of tons of our best coal have been wasted. The Coal Mining Committee in its report to the Government indicated that under Indian conditions hydraulic stowing (otherwise known as sand stowing) was the only economic and most satisfactory method of conservation of coal. If the Government put the recommendations of the Committee into effect by enforcing sandstowing by law, the important problem of safety in mines may be satisfactorily solved. The collieryowners have set up a strong agitation against compulsory sandstowing in coal mines, the necessary legislation for which is under contemplation by the Government of India. It is, therefore, necessary at the stage to draw the pointed attention of the public to the note of the Mining and Geological Institute submitted to the Burrows Committee:

"If we examine the balance sheets of some of the collieries which are in difficulties to-day for the past two decades, it will be astonishing to find the large profits which have been made during the development or the first stage of operation. That is, during the driving of galleries immense profits were made from huge outputs and in many cases 50 per cent of the coal had already been obtained at inflated profits during the last twenty years or so. A sinking fund should have been built up against the time when only pillar extraction with all its disadvantages would be available to maintain an economic output. That this has not been done does not affect Government. It has been an economic safeguard for which the companies themselves and the royalty owners are responsible. These two parties have already had quick and profitable returns and now desire State assistance to overcome difficulties of their own creation."

The other most important aspect of the question of conservation that demands our serious attention is the rationalization of coal production and coal consumption. This would be possible by making a thorough economic survey of all the coal fields in India and by undertaking a programme of intensive fuel research. The coke ovens owned by Government and by big industrialists at present use only superior grade coal for making coke and many of them recover the bye-products. Very little is known about the gas and tar producing capacities of second class Jharia coal, an immense quantity of which is annually used in making " soft coke Dr Roy computes that in the process of treating 3 million tons of these poorer grade of Jharia coal for making soft coke, about 30 million gallons of tar, containing valuable products, *i.e.*, (motor spirit, light oils and millions of cu. ft. of gas of good

calorific value and an enormous quantity of road tar), are lost to our country annually. Our home supply of liquid fuel being very inadequate, it is of fundamental importance to our country to carry out researches on our coal in order to find out ways and means to economically save these millions of gallons of tar which are now being wasted.

Dr Roy suggests other important lines of fuel research which would result in better utilization of poorer grade coals. Many inferior grade coals, which are supposed to be unsatisfactory for steam raising, can become quite good for locomotive firing and steam raising in general if made into pulverized fuel. But owing to easy fusibility of powdered coal, its heat raising quality suffers. If, as a result of research, it may be possible to hit at a poor grade of coal which does not fuse easily, it would then be quite suitable for all sorts of steam raising purposes and may easily replace first grade coal for such work and thus help to conserve metallurigical coal. Also the large reserve of high ash second class coal, which makes unsatisfactory soft coke at present, through research and treatment, might become a potential additional reserve for metallurgical purposes.

The other important natural fuel existing in our country is petroleum, but Indian resources for petroleum are exceedingly limited. Excluding Burma, India produces only a quarter of its present consumption of nearly 400 million gallons of petroleum annually. It is as much to the interest of the big operating companies who have secured the monopoly of production, as of the general public, that all wastes are avoided. There could, therefore, be no objection to adequate state supervision to ensure that production methods are always characterized by a realization of the importance of the conservation of oil and gas and prevention of waste. In countries like the U.S.A. with a well-developed petroleum industry, the Government actually employs a petroleum technologist to look after conservation and economic working of the resources of oil wells. Taking a long-range view, it is desirable that the petroleum fields of India should be controlled by such State supervisors.

Measures for conservation and waste in mining should also be undertaken at once in regard to minerals like mica, chromite and other metalliferous ores. India produces about 90% of the total commercial sheet mica production of the world and she can retain this position, provided the ruinous methods now employed by small mine-owners in "simply picking the eyes out of the mines" to obtain quick returns are given up. Small capitalists without technical knowledge and modern equipments work the mines usually to a very small depth, and these are left inside forests buried under the debris still containing lacs of rupees worth of minerals in their depths, which are totally lost to the country. State supervision that would safeguard the country from the dangers of ruining our mica and other metalliferous mines, without of course unduly interfering with legitimate private enterprises, would be quite welcome.

Another great source of loss to the mineral wealth of our country is due to very low price fetched by the export of some very useful minerals like manganese, chromite, bauxite, beryl etc., owing to their entire dependence on foreign demands. Except manganese they have very little or no demand in India, though we have to buy products manufactured from them at very high prices. With so many efficient chemists all over the country there is no reason why this should be allowed to happen.

We note from the programme published by the National Planning Committee, that fuel and metal industries have been included in the category of 'Mother' industries regarding which the Committee is expected to formulate schemes. We are sure that the Committee would pay due attention to the important problem of conservation and proper utilization of India's mineral resources. The Geological Survey of India, which has been the guardian of India's mineral wealth in the past, has rendered valuable services in the mineral exploitation of this country. But it is felt that a more intensive and extensive survey of India's mineral and metal resources are now necessary, and this can be undertaken by the co-ordinated endeavours of geologists, mining engineers and chemists, backed by the provincial governments. The National Pla

Committee should recommend the setting up of a National Industrial Research Board which may take up this work. It is only on the basis of the findings of surveys and researches conducted by such a competent body that a comprehensive and planned programme for future exploitation of the mineral and metal resources of the country may be undertaken.

Bengal Fisheries:
A Programme for Future Work

In our leading article in the last issue we stressed upon the necessity of paying more attention to the development and improvement of fisheries in this province and for the revival of the Department of Fisheries without the least delay so that problems of improvement of the fisheries and the lot of the poor fishermen of the province may be successfully tackled. We shall now suggest a brief outline of the programme for immediate working which may be undertaken by a well equipped and properly staffed Department of Fisheries.

The programme of work of the Fisheries Department can be divided into (1) work in reference to fisheries *sensu stricto,* and (2) socio-economic work in regard to both the fishermen and the fisheries.

With reference to (1), the department should carry out a detailed survey of the inland, the estuarine and, as far as possible, of the foreshore fisheries of the province. This should include not only a study of the various kinds of fish found in the different areas but also of the respective quantities available, the breeding seasons of different species, their migrations, maximum sizes attained, rates of growth, food supply etc. The life-histories of the different fishes of economic importance should be investigated in detail, and the questions of repopulating the depleted beds by nursing the naturally hatched young in special nurseries, and of augmenting their numbers, where necessary, by setting up hatcheries should be taken up. The artificial methods of breeding, however, do not, except in the case of the carps, seem to call for immediate action. For example, in the case of the *Hilsa* to which a great deal of attention was paid since Sir K. G. Gupta's recommendations for the establishment of hatcheries, it has, as a result of recent investigations carried out as a side line by the Zoological Survey of India, been found that the urgent need is not the establishment of hatcheries but the conservation of the young of this species which are captured and destroyed in very large quantities. The establishment of hatcheries or at least nurseries for various species of fish should, however, be kept as a part of the programme of work, as this in addition to increasing the fish supply would provide the material for studying the conditions under which the fishes thrive best, their rates of growth and various other biological factors concerned with their life.

The methods of capture and transport will also require detailed attention. As Sir K. G. Gupta remarked, there is very little in reference to the methods of capture which the Bengalee fisherman does not know, but the methods employed by him are often very wasteful and destructive besides being often crude and primitive; they must be improved and more rational and scientific methods of fishing for the conservation and improvement of the fisheries encouraged. In regard to transport, intensive research will have to be carried out for the best methods of transporting fish in as fresh a condition as possible either packed in ice or by the modern methods of cold storage. Where the supply is greatly in excess of the demand and cannot be consumed fresh or economically exported, the extra quantity available must be preserved by salting, smoking or by both. For fish suitable for canning,

the possibilities of producing tinned products of Indian fishes and the preparation of fish oil, fish meal and guano from the waste parts must also be explored.

With regard to the socio economic work, in addition to primary education it is essential to give the fisher-population simple instructions in the principles of co-operative working. Training must be imparted in the elementary basic facts of their calling and the value of the best and most economical methods of fishing and the use of more up to-date fishery appliances demonstrated. Another important aspect of the work is the very difficult problem of getting these fishermen out of the clutches of the money lending middlemen; for unless this is accomplished no marked improvement in the condition of the fishermen and, in consequence, of the fisheries is possible. Detailed attention must also be paid to improvements in the methods of marketing. At the present moment the arrangements for marketing are far from satisfactory. Fish is often plentiful in some areas while none is available in the neighbouring districts. As a result, the prices realized in the former are hardly remunerative, while in the latter exhorbitant prices prevail. Further, whereas the consumers have to pay a very high price, the poor fishermen do not get even a pittance. The condition and quality of fish offered in various markets is seldom controlled. In the above paragraph we have mentioned only a few of the numerous problems in reference to marketing and other socio-economic work which will have to be solved by the future Fisheries Department.

In the above suggestions for the work of the Fisheries Department the marine fisheries, both in the open sea and even the foreshore fisheries, have not been included, as we are of opinion that in the first instance efforts should mainly be concentrated towards improving the condition of inland fisheries, both freshwater and estuarine, to which the programme of work outlined above would equally apply. There can be no question that the problems in connection with the fisheries of the province are very intricate, they are much more so than those of agriculture and animal husbandry, but is that any reason for the utter neglect which seems to be their fate at the present?

Let us hope that the authorities and the public will realize their responsibilities, and that an early start will be made for the improvement of this very important and valuable asset of the province.

The Age of the MAHABHARATA

THE great Indian epic, the *Mahabharata*, has been the subject of critical study by scholars, Indian and European, ever since Sanskrit literature became known to Europe about 150 years ago. Many attempts have been made to fix up the date of writing of the epic, to find out whether the narrative part of the epic has any foundation on actual occurrences, and if so, what are the dates of these occurrences. The latest entrant in this interesting field is Prof. P. C. Sen-gupta, M.A., who, in an article published recently (*Jour. Roy. As. Soc. Bengal*, 3, p. 101, 1937), examines critically the astronomical references in the *Mahabharata* and concludes from these that the great fight between the Pandavas and the Kauravas occurred about 2449 B.C. It would be a great contribution provided the arguments of the learned professor can stand rational criticism.

We are afraid that this is not the case. Prof. Sen-gupta himself quotes in the beginning the opinion of the late Maharashtra scholar, Sankar Balkrishna Dikshit, that the *Mahabharata* in its present form was reduced to writing between 441 B.C. and 278 B.C. Probably compilation began on the earlier date and finished by the later one. Prof. Sen gupta himself accepts this view, and strengthens it by a quotation from the *Mahabharata* that the author of the epic was acquainted with Buddhist doctrines which he refutes.

We may add that the epic is permeated with anti-Buddhistic and anti-Magadhan feelings and probably even the great Emperor Asoka is villified as the incarnation of an evil minded *Ashur*, opposed to Vedic sacrifices (*Adi Parva*).

But in spite of all these references, it is quite possible that the story of the *Great War* may have been taken from other treatises, now extinct. In fact, references exist in the *Mahabharata* itself; the present form is ascribed to Vaisampayan and is said to have been recited at the court of Janamejaya (probably at Taxila), reputed to be the great grandson of the Pandavas. There is some probability that Janamejaya (lit. the Shaker of the People) is a historical personage, and was a great king, as reliable references to him as a conqueror, a great emperor, as one who oppressed the Brahmins and on whose descendants great calamities befell, are found in many *Brahmanas*, but we know next to nothing about his times, and no sure proof exists about his descent from the mythical Pandavas, excepting the story in the epic. It is quite possible that there were more than one Janamejaya.

Let us now see how Prof. Sen gupta deduces his dates. He rejects the authority of the majority of the *Puranas* that Parikshit, the reputed grandson of the Pandavas, flourished 1015 or 1050 years before the time of the accession of the first Nanda (350-400 B.C.) and shows that some of the astronomical references, connected with the various incidents of the great fight, clearly point to the fact that the Pleiades (*Krittika*) then formed the First Point of Aries (the point where the celestial equator cuts the ecliptic.) In fact, it is mentioned in the great epic itself that *Krittika* (the constellation of Pleiades) is to be regarded as the first of the *Nakshatras, i.e.*, the First Point of Aries (*Anushashan Parva*).

Prof. Sen-gupta comes to his conclusion after a laborious examination of many astronomical references,, found chiefly in the chapter dealing with the *Bharata* battle. It is unnecessary to refer to them in detail here, as we fully accept Prof. Sengupta's contention, that some of these astronomical references are consistent with the fact that *Krittika* formed the First Point of Aries. But there is another interpretation for this consistency, which we are afraid, has been missed by the author. This interpretation is that the epic-writer has purposely carried out back calculations, and interpolated astronomical references within the battle scene, just as writers of detective novels start with a plan of the house in which the plot is laid, and fit all incidents accordingly. Incredible as this suggestion would seem, this is the only explanation which can be given of these astronomical references.

The other alternative is that when the epic writer put the *Mahabharata* in its present form, about

400 B.C., he had older manuscripts, or records dating from 2450 B.C., which correctly and faithfully recorded the individual dates of the particular incidents of the fight. Now we know that in the ancient world, least of all in India, chronological calculations were not very much developed. In view of ahistoric way in which traditions have been recorded in the *Vedas* and the *Upanishadas*, we shall be ascribing too much knowledge to ancient Indians if we suppose that they correctly remembered, down to the minutest details of the phases of the moon, dates of incidents which occurred 2000 years before the time of writing. It may be argued that the writer had the historical sense to recover correct dates from old records or inscriptions. But a critical examination of the story in the epic shows that the writer was devoid of any such historical sense. Though he professes to have written a story of ancient times (*Itihasa*), what he has actually written is a didactic poem in which the great names of ancient times, floating round popular traditions of his times, were brought on one canvas and made to play parts round his central ethical theme. This was his exultation of Brahminism, and of the sacrifices, denunciation of heretical doctrines, particularly of Buddhism, and a covert hostility to the empire of Magadha which was flourishing in its full glory during his time. In trying to do so, he has been guilty of many hopeless anachronisms, just like the Greek epic writers.

We have to justify this rather scathing remark.

The epic describes a fight between two rival families who are said to have been connected as shown below:—

SANTANU

(1) Bhisma (2) Vichitravirya

(3) Dhritarastra (4) Pandu (Progenitor of the Pandavas)

(5) Duryodhana and other Kauravas (6) Yudhisthir and other Pandavas (7) Arjun

(8) Abhimanyu

(9) Parikshit

The epic makes Bhisma (1) fight duels with Abhimanyu (8) who is, as the table shows, fourth in descent from him, but is really fifth. For Bhisma, when a full grown youth, renounced marriage and throne, at the request of his father Santanu and the girl who would have been his bride became his father's wife, and later became the mother of Vichitravirya. (2) So Bhisma was at least eighteen years older than (2), who died childless in his youth, on account of sexual excess, after a married life of some years. (3) and (4) are said to have been procreated by the sage Vyasa on his widowed wives. So (1) was older than (3) or (4) by at least 40 years. At the time of the battle, (4) was dead, (3) is said to have been an old man, and parties (6) and (7), who were mature men, were contending for the throne. The children of (6) and (7) were grown up youths, and one of them, Abhimanyu, was old enough to procreate a son (the posthumous Parikshit). So (5) and (6) must be about 40, (3) would be about 60, and (1) would be about 100 years of age. Now the epic writer makes (1), a man who was at least a nonagenarian, fight duels with (8), who was probably a youth of 18. This shows that the writer of the epic had no knowledge of actual facts, but based his story on vague traditions. That he was to some extent conscious of the incongruity is clear from the fact that he invents a myth that Bhisma, as a result of his great renunciation, got the blessing from his father, that he would be *Icchamrityu, i.e.*, he could die at any time he liked. But a twentieth century man cannot put any trust in such nonsense.

I have pointed out only one of the absurdities in the epic story, but others may be multiplied. The descriptions of the battles must have been written from imagination by people, who had never seen any actual battle. They are too romantic, if not absurd. Before the battle, the Pandavas were encamped at Upaplavya, a city in the *Matsya* territory (near Jaipur) and the Kauravas were at Hastinapur, (Meerut District). They should meet midway, or near the one city or the other. Why should they march full hundred miles to the north, to Kurukshetra for a fight? It is against all canons of warfare.

These criticisms show that the writer had no actual knowledge of the fight, except vague traditions, which he wove into an improbable story. Like all ancient writers, he crowded all floating heroes,

who lived in popular traditions, on one canvas. It is quite possible that the principal characters described, even if they had corporeal existence, were widely separated in space and time. This sort of incongruous blending generally happens during an epic age when a period of unrest or great changes, due to introduction of new ideas, or of an aggressive foreign culture, separates two distinct epochs, and the real historical perspective of the previous epoch is lost and only floating traditions remain. It is then that, as a reaction to the prevailing culture, or merely from a spirit of romance, the past is visualized in a romantic light, and epics describing the actions of past heroes arise, not in their true historical setting, because the history is lost, but in a romantic colouring. Very often heroes separated in space and time are crowded together on the same canvas. This is true not only regarding the Indian epics, but also for those of other countries.

Thus, for example, Homer's story of the sack of Troy has been proved by Schliemann's excavations to be based on historical happenings which took place about 1200 B.C. The perpetrators of this enterprise were probably the Achaeans, the Akaiwasha of Pharoah Ramses's inscription. (1200 B. C.) who were the authors of the Mycenaean civilisation on the Greek mainland. But by the time the *Iliad* was written (about 800 B. C.), the Achaeans were conquered by invaders from the north who grew to be the Greeks of classical times, and they heard the story of sack of Troy, and a poet arose who wove the story into an epic poem. But the Achaeans were transformed into Greek heroes, and every Greek City State of note at the time the poem was compiled was given the honour of contributing a hero for the sack of Troy. Characters separated in space and time were crowded on one canvas.

Further examples are Firdausi's *Shahnamah* or, in modern times, Tennyson's *Morte d'Arthur*. Firdausi, writing in the eleventh century, wrote about the glories of ancient Iran, of the great Sassanian dynasty, which was overwhelmed by the Arab invasion of 648 A.D. After nearly 400 years of Arab domination and influence of Islam, the historical knowledge and time sense had disappeared, only vague traditions, and a vague sense of past glory of Iran had remained. Out of these Firdausi, a patriotic Iranian, wrote his great epic from a sense of national pride in the glories of ancient Iran. But anybody who would try to construct history of ancient Iran of the Achaemenids or even of the Sassanians out of Firdausi's romance would find himself hopelessly in contradiction with facts. In fact, the royal dynasties of Iran given by Firdausi can be with difficulty identified with the Arsacids and the Sassanians, but there is no trace of the Achaemenids in his epic.

Tennyson has revived out of old traditions, the romance of *Morte d'Arthur*, a virtuous and model Christian king of pre-saxon England. The original model seems to have been a certain British war leader, Artus (his historicity is not beyond doubt) who appears to have opposed the invasion of the West Saxons. Nobody would think of constructing the history of pre-Saxon Britain from Tennyson's great romance.

The contention that writers of heroic poems are fond of crowding popular characters separated by space and time on one canvas can be also illustrated from Indian history. When the North-Indian Rajput dynasties were overthrown by the Turkish invaders and genuine history was lost, the bards began to sing of old heroes in ballads out of which Tod compiled his romance of Rajasthan. In these ballads, most hopeless anachronisms were committed. For example, Prithwiraja of Ajmere, and Rana Samar Singh of Mewar were described to be brothers-in law, and made to fight Mohammed Ghori in alliance. Now, modern historical research has shown that Maharawal Samar Singh of Mewar flourished full hundred years after Prithwiraja (1302 A. D.), and, therefore, could not have been Prithwiraja's brother-in-law. The ruler of Mewar contemporary with Prithwiraja bore a totally different name, and there was no proof that he rendered any help to Prithwiraja. But the bard who wrote probably about 1500 A.D. had no historical sense, and could not resist the temptation of bringing two great Rajput chiefs, separated by full hundred years, on one canvas. In fact, Tod's *Rajasthan* is full of unreal statements *e.g.*, the story of Padmini, which has been shown to be a mere myth, having no foundation on fact (*vide* Gourisankar Hiranand Ojha's *History of Rajasthan* in two volumes).

THE AGE OF THE MAHABHARATA

We are convinced that the *Mahabharata* writer of the fourth century B.C., having got his story from similar bardic ballads, has committed similar mistakes. It is as futile to look for historical matter in the *Mahabharata*, as it would be in Firdausi's *Shahnamah*, or Tennyson's *Morte d'Arthur*.

What were then the motives which led to the compilation of the *Mahabharata?* It must have been reaction to Buddhism, and to the growing political supremacy of Magadha on the Indian continent, when the story was compiled. For, the central theme of *Mahabharata* is to glorify the Brahmins and their sacrifices, which were at that time openly declared by the heretics (the Buddhists and the Jains) as being of no ethical, or magical value.

At that time, the Mauryan Empire was at the height of its power, and even before Asoka, the Magadhan emperors were heretical in their views. The Brahmins wanted to tell the people that even before the rise of the Magadhan Empire, India was united under one empire, on the principle of a *Dharmarajya* consecrated by a great sacrifice, a feat which was possible by the co-operation of the virtuous Pandava brothers and Krishna, leader of the powerful Yadava clan. The heroes were chosen haphazardly out of old floating traditions which, strangely enough, were used by the Buddhists also for illustrating their own moral theme, which is so different from the Brahminic idea of morality. The Buddhist scriptures preserve traditions of a great kingdom of Kurus with capital at Indraprastha with king Dhananjaya at its head, and Bidur as prime minister. The kingdom was supposed to have been governed on perfect principles of righteousness, and both the king and the minister were held as models. In fact, Buddha was said to have been born as Bidur in some of his previous incarnations. Sometimes the king was described as belonging to the Yudhisthir *gotra* (clan). These traditions show that at the time of Buddha, though people remembered a virtuous line of Kuru kings reigning at Indraprastha and bearing names like Yudhisthir, Arjun or Dhananjaya, they had no definite historical knowledge about them. Similarly, there was then traditions of a great Yadava leader Krishna who was also a student of Upanishadic philosophy and whose tribe perished as the result of internal fighting, result of a drinking orgy. The *Mahabharata* writer brings all those heroes on one canvas, and makes them subvert the wicked empire of Magadha (that of Jarasandha), which encouraged heresy and establish a kingdom of righteousness as understood by the sacrificing Brahmin priests. There is no proof yet that the characters were historical, or even if historical, that they flourished at one and the same epoch. The story writer has brought them together to heighten the effect.

There is no doubt that the epic preserves echoes of great historical events occurring on the Indian continent between 600 B.C. and 2600 B.C. (time of Mohen jo Daro), but to find out the actual historical facts behind them, we must wait till archaeological excavations are carried out at the sites reputed to be connected with these incidents.

In fact the rational interpretation of the Mahabharatan story appears to be that it was compiled out of a mass of floating bardic lore current during the fifth century before Christ about the heroic actions of royal dynasties of the Pandavas which, shortly before this time, reigned at Indraprastha and Kausambi, but which were supplanted by Magadhan imperialism, just as Tod constructed his story of the heroes of Mewar out of bardic lore, long after the house of Mewar had lost its independence or ceased to be important. But while Tod wrote a chronicle, the writer of the *Mahabharata* wrote a didactic poem round a central theme (setting up of *Dharmarajya* according to the Brahminic conceptions of social ethics): what we call a sense of historical criticism was absent in both.

If this theory be accepted, it is difficult to see how the bards on whom the compiler of the *Mahabharata* depended could have transmitted correctly for two thousand years the exact phases of the moon on the dates when the various fights of the *Bharata* battle were supposed to have occurred. Further, though there was memory of a great battle fought between scions of a great royal house, all details of the battle were lost, the battle scenes as recorded in the epic are merely invented stories, rather than echoes of actual occurrences. The only correct tradition which is preserved in the Pauranic literature is that the battle occurred 1015 or 1050 years before the time of the Nandas.

Such invented battle stories can be found even now. Even the late Mr R. C. Dutt, who had an acute historical mind, while trying to write the story of Haldighat for a Bengali novel, invented an improbable story. He makes Rana Pratap Singh fight a personal duel with Selim, the Crown Prince, which is impossible, because Selim was, in 1576, the date of Haldighat, a mere lad of eight, and now we know from the actual story of Haldighat, as recovered from contemporary chronicles, that the battle story was quite otherwise, and Selim was not at all present in the battle. The battle-stories of the *Mahabharata*, being themselves mere inventions, no reliance can be placed on the dates, or rather the phases of the moon recorded there.

Why the *Mahabharata*, writer, then, interpolate these dates, and how could he do it? This is quite a simple matter. It is recorded in the *Taittiriya Brahmana* and other early texts that the *Krittika* was the first of the *Nakshatras*. The *Satapatha Brahmana* shows knowledge of Babylonian mythology *e.g.*, the story of the Great Flood as found in this *Brahmana* is a mere variant of the Babylonian flood story. Probably in recording that the Pleiades was the first of the *Nakshatras*, it simply echoes the Babylonian custom of regarding the Pleiades as the true East, which became current in Babylonian astronomy from the time of the last dynasty of Ur (about 2300 B.C.).

The *Mahabharata* writer, when he wanted to date his events, simply fell on this old tradition of regarding the Pleiades as the First Point of Aries, and dated every incident accordingly. Even the crude astronomical knowledge, as recorded in the *Paitamaha Siddhanta*, or earlier, in the *Vedanga Jyotisha* which were current about 400 B.C., was quite sufficient for this purpose. So we need not attach any historical importance to these astronomical references, and any attempt to recover historical dates from them is bound to be futile.

The *Mahabharata* writer, of the 4th century B.C., while inserting astronomical references, merely calculated back on the assumption that the Great War was fought when the Pleiades formed the vernal equinoctial point, because this was the older tradition.

M. N. S.

Supplementary Astronomical Notes to the above article

For the reader who is not acquainted with astronomy, the following notes may be helpful.

The ecliptic or the sun's path is a great circle (inclined at about 23°28′ to the equator), which marks the position of the sun along the heavens. It is divided into 12 equal divisions, each of 30°, and they are known as Aries (Ram), Taurus (Bull), Gemini (Twin), Cancer (Crab), Leo (Lion), Virgo (Virgin), Libra (Scales), Scorpio (Scorpion), Sagittarius, (Archer), Capricornus (Sea-goat), Aquarius (Water-bearer), Pisces (Fishes). The names represent the constellations of stars through which the sun passes, in course of a year.

The moon's path on the celestial sphere is also a great circle, inclined at about 5° to the ecliptic and for all practical purposes, may be taken coincident with the ecliptic. The moon completes its revolution in about 27⅓ solar days, and many ancient nations divided the path into 27 to 28 parts, and called each a Lunar Mansion, (or *Nakshatra* in Sanskrit, *Manzil* in Arabic). Each lunar mansion is about 13⅓°. About 2¼ lunar mansions constitute a zodiacal sign. Thus the Sign of Aries originally comprised. *Aswini* (β, γ Arietes), *Bharani* (a b c Musca), and quarter period of *Krittika* (or Pleiades).

From which point to begin the counting of stars on the ecliptic? The two points of intersection of the ecliptic and the equator are technically known as the First Points of Aries and of Libra respectively. When the sun is at the First Point of

Aries, we have vernal equinox, day and night are equal, and the astronomical spring begins. The other point forms the autumnal equinox. It is from the First Point of Aries that star counts ought to begin. But the equinoctial points are not fixed. They recede at the rate of 50″ per year and will make a complete revolution round the ecliptic in nearly 26,000 years. At about 505 A.D., the vernal equinoctial point was at ζ-Pisces, close to Aries. But at that time, the point was supposed (at least in India) to be fixed, and it received the name First Point of Aries. Though the vernal equinoctical point has now receeded by about 23°, and is almost at the end of the Sign of Fishes, the same 'First Point of Aries' for the vernal equinoctial point still persists.

Says Arthur M. Harding, in the *Journal of Calender Reforms.*

"Just west of the brilliant Orion, in the constellation Taurus—the Bull—is a little group of stars called the Pleiades which may be easily identified. The Pleiades lie on a region of the sky which was at one time of much greater importance, than it is today. About 4,000 years ago the vernal equinox the point occupied by the sun on March 21—was very close to the Pleiades so that those days the Bull, and not the Ram, was the first constellation of the zodiac.

Proof has recently been found of the fact that the Persians and the Chinese began their Zodiac with the Bull and it is said that a burial chamber has been excavated in Egypt showing a list of constellations of the zodiac with the Bull at the head of

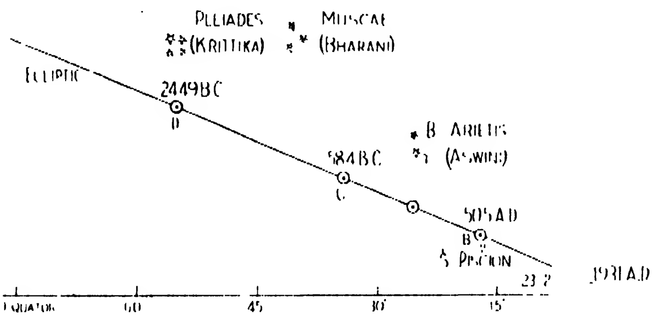

DIAGRAM SHOWING PRECESSION OF VERNAL EQUINOX ALONG THE SUN'S PATH (ECLIPTIC)

TIME	VERNAL EQUINOX	
2449 B.C.	KRITTIKA PLEIADES	BABYLONIAN STARTING POINT
584 B.C.	NEAR BHARANI MUSCAE	OLD GARGA
505 A.D.	ζ-PISCION	VARAHAMIHIR
1931 A.D.		PRESENT POSITION

Let us now go backwards in time, say about 2,400 B.C. The vernal equinox was then at the lunar mansion of *Krittika*, at the very conspicions constellation of stars called the Pleiades. The Babylonians who believed that the planets control the destinies of men, had just started observing the motions of planets in their temple observatories, and they noticed that the heliacal rising of Pleiades (i.e. rising of the star-group at dawn) fell on vernal equinox. They started the custom of regarding the Pleiades as the first of the lunar mansions. As it was not then suspected that the vernal equinoctial point had a slow retrograde motion, the custom of counting the constellations from the Pleiades persisted for thousands of years even up to Roman times.

them. In the astrological books of the Jews the Bull is considered as the first zodiacal sign, and the classical poets tell us that bulls were frequently sacrificed to Jupiter and that the priests performed these ceremonies in the disguise of a bull-headed monster. Does not Virgil say, "the Bull with his golden horns opened the year!"

Because of the precession of the equinoxes, which makes it necessary for us to distinguish between signs and constellations of the zodiac the vernal equinox has slowly retrograded since that time, first through the constellation of the Fishes. But 4,000 years ago the Bull was the leading sign and the Pleiades were extremely close to what was probably the most important point in the sky.

About 4,000 years ago, when the Bull was the first constellation of the zodiac, the Chaldeans made very accurate measurements of time. Our information about their calender and their astronomical observations has been obtained from an ancient work called *The Observations of Bel*, supposed to date from about 1700 B.C. This work consists of 70 books written on small earthen tablets. The results of the observations of the Chaldeans must have been known to later peoples for the celebrated astronomer, Ptolemy, made use of three eclipses which were observed in Babylon in 721 B.C. and 720 B.C."

Even the Sanskrit books which are supposed to be much older than the *Mahabharata* in their date of composition or compilation echo the view that the Pleiades form the vernal equinoctial point. The epic describes a fight between two rivals. The *Satapatha Brahman* says: "*The Pleiades never deviate from the true East.*" This may be an echo of the old time custom of regarding the Pleiades as the first. About 584 B.C., Old Garga,* a pre-Greek Indian Astronomer noticed that the equinoctial point had shifted to Bharani (*a b c* Musca). Varahamihir in 505 A.D., fixed upon ζ-Pisces, close to the sign Aries, as the First Point of Aries, and the custom of regarding Aries, the Ram as the first sign, still continues amount Indian almanac makers of old style, though the equinoctial point has shifted about 23° west, and is now in the sign of Pisces. In Hindu almanacs, the 30th or 31st of *Chaitra* is known as the *Maha Vishubh Sankranti*, the vernal equinoctial day. But the actual equinoxes occur on the 8th Chaitra, nearly 21 days earlier. Suppose two thousand years hence, some body comes across an almanac of 1939 stating 30th *Chaitra* as the vernal equinoctial day. He would conclude from astronomical calculation that the almanac was dated 505 A. D.

*This is the date assigned to old Garga by Zinner, in his *Geschichte der Sternkunde*, p. 174. Old Garga appears to have had some sort of observatory on the banks of the ancient Saraswati, and is referred to in the *Mahabharata*. But he must not be confused with the later Garga, author of *Garga Samhita*, which talks of Sunga times.

Mineral Production of India and Burma

For sometime past, the Geological Survey of India has been publishing annual reviews of mineral production in the country. At present, trustworthy annual returns are available for most of the more important minerals in India, the collection of reliable statistics being impossible only in the case of minerals exploited mainly by primitive Indian methods by persons working independently and on a very small scale. But the error in the annual figures for production of even this class of minerals would be characterized by some degree of constancy and a comparison of these figures for successive years would enable one to follow the general trend of the Industry.

Interesting and important information is available from the recent publication in the records of the Geological Survey of India of the annual returns for Mineral Production in India and Burma during 1937.* In the following tables are shown the total value of minerals in India and Burma, for which returns of production are available for the years 1936 and 1937. The figures given include the total production of British India as well as of the Indian States, the data for which are provided by the Chief Inspector of Mines, the Local Governments, the Indian Durbars and the Political Agents for Indian States and Managements of Mining Companies.

* *Records of the Geological Survey of India*, Vol. 73, Part 3, pp. 303—397, 1938.

MINERAL PRODUCTION OF INDIA AND BURMA

TABLE I

Total value of minerals for which returns of production in India are available for the years 1936 and 1937.

	1936 £	1937 £	Variation per cent.
Coal	4,699,128	5,872,364	+ 25·0
Manganese ore ..	1,124,422	3,229,554	+ 187·2
Gold	2,293,113	2,285,404	0·3
Mica	689,963	1,079,702	+ 56·5
Petroleum ..	915,188	1,030,591	+ 12·6
Building materials ..	658,501	728,562	+ 10·6
Salt	554,099	612,584	+ 10·5
Copper-ore ..	300,993	366,280	+ 21·7
Iron-ore ..	294,125	344,840	+ 17·3
Ilmenite ..	62,423	84,686	+ 35·7
Saltpetre ..	86,273	84,048	2·5
Chromite ..	45,450	62,826	+ 38·2
Refractory materials	29,798	55,970	+ 87·8
Clays	22,057	24,229	+ 9·4
Magnesite ..	7,684	12,326	+ 60·4
Steatite ..	11,803	11,671	− 1·1
Barytes ..	1,206	11,223	+ 830·6
Monazites ..	8,116	10,554	+ 30·0
Gypsum	7,396	8,913	+ 20·5
Fuller's earth ..	5,389	5,640	+ 4·7
Bauxite ..	548	4,650	+ 748·6
Diamonds ..	4,675	4,134	11·6
Zircon	6,335	2,935	− 53·7
Silver	2,528	2,432	3·8
Tungsten-ore ..	..	1,842	..
Ochres	2,749	1,788	− 34·9
Graphite ..	331	1,226	+ 270·4
Asbestos ..	234	453	+ 93·6
Felspar ..	454	255	− 43·8
Beryl	466	148	68·2
Apatite ..	99	125	+ 26·3
Garnet ..	5	124	.
Bentonite ..	102	68	− 33·3
Sapphire ..	1,682	41	97·6
Tantalite ..	76	23	69·7
Soda	..	2	..
Total ..	11,837,411	15,942,213	+ 34·7

The aggregate increase in the value of the production of all minerals in India in 1937 was £4,104,802 or 34·7 per cent and in Burma was £1,839,434 or 24·9 per cent.

The average figure for the quinquennium 1919-23 was £25,194,123. In 1924 there was an apparent increase due to higher average value of the rupee during that year. Then began a steady decline and in 1928 it came down to £21,888,528. The figures for 1929 record a slight increase of 2% but the decline was resumed and the lowest figure, £15,512,235, was reached in 1932. In 1933 the tide turned again and the rise continued till 1935, when it reached £19,346,880. In 1936 there was a small increase of £76,431 and in 1937 a great increase of £5,944,236 for India and Burma combined.

TABLE II

Total value of minerals produced in Burma, for which figures of production are available for the years 1936 and 1937.

	1936 £	1937 £	Variation per cent.
Petroleum ..	3,736,805	4,474,147	+ 19·7
Lead	1,269,262	1,801,719	+ 41·9
Tin concentrates ..	780,689	824,001	+ 5·5
Tungsten concentrates	307,624	603,214	+ 96·1
Silver	516,660	553,458	+ 7·1
Zinc concentrates ..	303,356	409,054	+ 34·8
Building materials	158,211	194,550	+ 22·9
Copper matte ..	151,126	181,839	+ 20·3
Nickel speiss ..	111,489	104,590	6·2
Salt	37,257	62,026	+ 66·5
Antimonial lead ..	26,036	31,652	+ 21·5
Jadeite	13,412	13,030	2·8
Iron ore ..	7,915	7,647	3·4
Ruby and sapphire ..	7,319	7,069	3·4
Gold	7,820	6,333	19·0
Clays	1,540	1,367	11·2
Amber	409	668	+ 63·3
Total ..	7,436,930	9,276,364	+ 24·9

Coal and petroleum remain at the head of the list with production figures of over five and a half million sterling and manganese ore comes third with three million four hundred thousand sterling.

Of the more important minerals, percentage increases are shown by coal in India of 25.0, petroleum in Burma of 19.7 and in India of 12.6, manganese ore of 187.2 in India, mica in India of 56.5, lead in Burma of 41.9, building materials in India of 10.6 and in Burma of 22.9, tin concentrates in Burma of 5.5, salt in India of 10.5 and in Burma of 66.5, tungsten concentrates in Burma of 96.1, copper ore in India of 21.7 and copper matte in Burma of 20.3, iron ore in India of 17.8, silver in Burma of 7.1, and zinc concentrates in Burma of 34.8.

MINERAL PRODUCTION OF INDIA AND BURMA

Gold shows a trifling fall of 0.3 percent for India and 19.0 per cent of Burma's small production and nickel speiss for Burma of 6.2 per cent.

The average number of persons employed daily in 1937 in the production of minerals from mines in India (figures from Burma are not available) for which reliable returns of labour statistics are available, was 373,129 against 342,766 in the previous year. The important mineral industries in providing employment are, in order, coal, salt, manganese ore, mica, gold, and iron-ore. Additional employment is of course provided in the transport, smelting and refining industries.

The number of mineral concessions granted in 1937 was 291 prospecting licenses, 57 mining leases and 25 quarry leases in India and 271 prospecting licenses and 46 mining leases in Burma. These figures are much above the average figure for the last five years and show that interest in mining enterprise is reviving after the period of depression

S. D.

The Sugarcane

Botanically the sugarcane belongs to the great family of the Grasses, a family which man has exploited more than any other group. In the case of sugarcane, he has not bothered about the grain, he is concerned with the stem of the plant and with the sweet sap which that stem contains. As to the place in the world where sugarcane originated, some consider that its original home was New Guinea and others, that it was India, where it may have arisen from the wild sugarcane. This wild sugarcane is still with us. It is one of the commonest grasses in many parts of India, known by such local names as *Kans*.

The number of sugarcane varieties now available is due to the work of plant-breeders, and their work is made possible by the fact that the sugarcane does, in certain circumstances, produce real seed. Seedlings raised from these seeds often do not exactly resemble the parents and this variation can be combined into one, and this has been done repeatedly so that some of the canes grown in India today have a most complex parentage, including among their ancestry the wild sugarcane.

Everything has an exception, however, and cases have been observed where suddenly a different kind of cane springs up from a planted set. This "sporting" as it is called in gardening language or bud mutation as it is called in scientific parlance, is most obvious in coloured canes. Recently sugarcane scientists in Mysore have found that this kind of sporting can be induced if the bud of a sugarcane is subjected to X-ray treatment. The Imperial Council of Agricultural Research has been helping to finance this work, which is of scientific importance and has already given some promising variants. These have been called Mysray varieties.

One of the most interesting ways of trying to deal with insects, who bore into sugarcane and destroy it, is what is known as biological control. This consists in finding other insects which will live on the pests and eat them. Some very interesting and successful work of this kind has been carried out at Mysore and also in Orissa using a small wasp Trichogramma which lays its own eggs in the eggs of the borer. This Trichogramma has got to be multiplied and this is done by allowing it to breed on the eggs of another insect which it parasitises. This other insect is none other but that loathsome caterpillar which you find crawling about in old grain or flour. After getting the wasps so multiplied the parasitised eggs of the rice insect are then put out in the field in large numbers in the hope that when the wasps emerge they will go for the eggs of the borer wherever they find them. Combined with this is a system of earthing up the base of the cane to prevent the borers getting in between the leaves and the stem, and a combination of the two methods is promising in certain areas.

—*From a broadcast talk by* Dr W. Burns *at Delhi*

Is Life Possible in other Planets

(Continued from the last issue)

K. R. Saha and A. K. Saha

In our previous article, we discussed in a general way the necessary requisites for any form of life to exist on the different planets. We also discussed what are the methods of investigating the physical conditions existing over the surface of other planets. In the present article we shall discuss in greater detail the results of such investigations for each planet and see what light they throw on the question of existence of life in other planets of our solar system.

Mercury

This planet which is nearest to the sun is exceedingly small, its mass being only 1/24 that of earth. Velocity of escape is very low (3.6 km/sec). Mercury always turns the same face towards the sun and the temperature of the sun-lit face may be as high as 350° C, whereas the temperature of the other face must be very low. It is therefore improbable that Mercury should possess any atmosphere. This is confirmed by the exceedingly small value of albedo (0.07) which is even smaller than that for the moon. This indicates that light is reflected from a bare solid surface and the planet has no gaseous envelope with clouds floating in it. The spectroscopic experiments likewise do not give any evidence for the existence of any atmosphere on the planet. The prolongation of the horns of crescent by twilight has never been observed for Mercury. Mercury has probably as rough a surface as the moon. Considering all these we may say with absolute certainty that no life can exist on this planet.

Venus

Infinitely more deserving of interest is the beautiful planet Venus, the twin sister of the earth. It is the most brilliant luminary next to the sun and the moon in the heavens and appears for a part of the year as an evening star and for another part as a morning star. This planet resembles the earth in many respects. Its mass, surface, volume and density are all very nearly equal to those of the earth. The velocity of escape is 10 km/sec. which is almost equal to that for the earth and the value of the albedo is 0.62 which indicates that the planet is completely enveloped by a much thicker layer of clouds than even the earth. There are no conspicuous surface-details, though Ross in 1927 observed some ill-defined markings of very short duration in photographs of the planet taken with ultra violet light, which are perhaps due to variation of reflectivity of cloud sheets. Differences of tone have been reported by observers, who would have us believe that these are due to changing density of clouds covering the planet. But these reports differ from each other so widely that we cannot accept without doubt the real existence of these variations of tones on the surface of Venus. The velocity of rotation of the planet is very uncertain and has been given values ranging from 24 hours to several months. This is due, no doubt, to absence of prominent surface markings which renders the observation of rotation of the planet extremely difficult. Pettit and Nicholson have however observed that the temperature of the dark side is uniform and not very low, being about -25°C. The sunlit face is not much hotter which can only be explained on the assumption that this is the temperature of the reflecting surface of the high clouds covering completely the surface of the planet rotating with finite velocity round its axis. If the planet were to turn always the same face towards the sun, the temperature of the illuminated face would have been much higher while that of the dark face would have been much less than what are actually observed. It might be suggested that heat would travel from the sunlit face to the dark side reducing thereby

the difference of temperatures of the two faces. But considering the relative smallness of this difference, we have to admit that this process of transference of heat from one face to another would not suffice, and the planet must consequently be supposed to rotate. The evidence for the presence of an atmosphere on Venus is conclusive. The velocity of escape and the temperature prevailing over the surface of Venus suggest that an atmosphere very similar to the earth's might exist on Venus. The existence of thick clouds also indicates the presence of an atmosphere for clouds consist of liquid drops suspended on dust particles which float in a gaseous medium. At the time of inferior conjunction and on such rare occasions when, the planet is within 1° of the sun, the horns of the crescent, as already explained, extends much beyond the diameter. Some observers of repute claim to have seen the cusps run together giving rise to a ring of light round the dark disc of the planet. This fact indicates conclusively the presence of an atmosphere. The spectroscopic method of observation fails to reveal the composition of any atmosphere below the cloudy envelope, for solar radiation can not penetrate these thick layers of clouds. All that it can do is to enable us to study the nature of the atmosphere above the apparent cloudy surface of the planet and this gives us some surprising and interesting results. Researches of St John and Nicholson show that there is negligibly small quantity of oxygen in the atmosphere of Venus, which may be even less than one thousandth part of that in the earth's atmosphere. They arrived at the same conclusion for water vapour. In spectral photographs taken by Adel and Slipher certain bands were observed of which the heads corresponded to 7820 Å and 7883 Å. Adam and Dunham from certain theoretical considerations concluded that these lines are due to carbonic acid gas. In experiments performed in the laboratory identical bands were obtained for carbonic acid gas and by comparison of the intensities of the lines obtained in the two cases, the amount of carbonic acid gas in the atmosphere of Venus was estimated to constitute a layer of 500 to 3000 metres thickness at N.T.P. It is certain that the atmosphere of Venus contains very little oxygen or water vapour but is mainly constituted of carbon dioxide and probably nitrogen.

We may compare Venus with the earth, as it was in the Azoic Age say about 1000 million years back. Our planet was then probably a whirling ball of intensely hot liquid with a thin hot crust floating over it, travelling in space at a terrific speed. As it cooled, crusts of rocks were in the process of formation. These were mainly oxides in the form of aluminium and silicate slags. As a result, all the oxygen free at that time was used up and the terrestrial atmosphere at that time must have been consisted principally of carbon dioxide and nitrogen. Very little of the water that is condensed in our oceans today, probably was present, but as the earth cooled down further, water was freed from the silicates in the magma of the earth, in which they were dissolved and more rocks were formed over the hot liquid nucleus. In the following Proterozoic and Palaeozoic periods, lower forms of life like algae, worms, seaweeds began to be born in the shallow pools and slowly an atmosphere of oxygen exhaled by these low forms of vegetable life inhaling carbon dioxide from the atmosphere began to be built up. So that when Mesozoic and Cainozoic Ages came, the earth was fit enough for the existence of superior forms of life like reptiles and the mammals, who breathed in oxygen and exhaled carbon dioxide. Forests, swamps and grass also came into existence and these continually replenished oxygen in the atmosphere. Most of the geologists believe that all the oxygen in the terrestrial atmosphere today is of vegetable origin. Assuming Venus to be in its pre-Azoic stage, we can expect, on the above evolutionary theory, that some thousand million years hence, life which now does not probably exist may come into existence on Venus, very much in the same way as it has done on our earth.

Mars

This beautiful red planet interests us more than any other in the solar system because there is greater probability of life on it. Its mass is 0.1076 of the earth's and its density is 0.72. Velocity of escape is very small (5.04 km/sec). The value of the albedo (0.154) indicates that the Martian surface is made up not merely of dark coloured rocks but there is also some slight atmosphere

VENUS

FIG. 1. Absorption band due to CO_2 in Venus. (From a photograph by Dunham and Adams).

MARS

FIG. 2. *Upper*—Absorption band due to water vapour (indicated by *a*) in Mars;
Lower—Spectrum of Moonlight under the same conditions. (From photographs by Slipher).
Observe water vapour bands are stronger in Mars.

MARS

FIG. 3. Band B of oxygen molecule.
Upper—Mars (V = − 13·76 km/sec.)
Middle—Sun.
Lower—Mars (V = 12·4 km/sec.) (From a photograph of Dunham and Adams).

BIGGER PLANETS

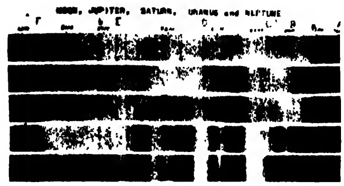

FIG. 4. Spectra of Major Planets.
Upper—Moon then in order Jupiter, Saturn, Uranus, Neptune.
Notice that the absorption bands due CH_4 and NH_3 grow in intensity as we proceed from Jupiter to Neptune.

CLOUDS ON MARS

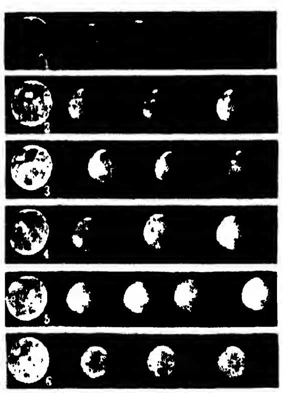

FIG. 5. Photographic evidences of occasional appearances of clouds on Mars. Photographs 1, 2, 3, 4 and 5 are taken successively on different dates with yellow filter. A bright marking appears on 2, lasting only a day or two and disappears from 4, which is taken one day after 2. The drawings on the extreme left made by visual observation also reveals the appearance of this transient bright marking. Photograph 6, is taken on the same night as 2 with blue filter and does not reveal the presence of this bright marking showing that its colour is yellow. (From photographs by Slipher).

SEASONAL CHANGES OF THE MARTIAN DISC

MARTIAN DATE | SOUTH | MARTIAN DATE

MAY 11 — JUNE 23

MAY 29 — JUNE 31

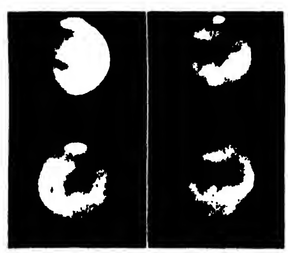

FIG. 6. Seasonal changes on the Martian disc.
Upper—Photographs of Mars showing a gradual diminution of the dark areas with the advance of summer in the southern hemisphere of Mars. (From photographs by Slipher).
Lower—Drawings of the Martian disc by Lowell, showing that with advancing summer, the canals in the northern hemisphere gradually increase in darkness and prominence whereas the canals in the southern hemisphere fade out.

ULTRA-VIOLET PHOTOGRAPH OF VENUS

Fig. 7. Photographs of Venus in ultra violet light. Note differences of tones in these two photographs (taken in 1927 by Ross).

INFRA-RED AND ULTRA-VIOLET PHOTOGRAPHS OF MARS

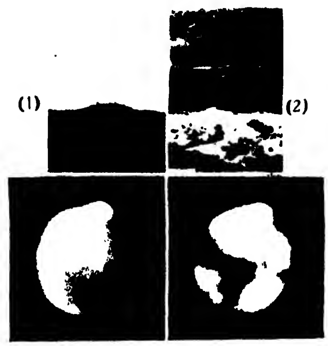

Fig. 8. Infra red and ultraviolet photographs of Mars. The photograph (3) is taken with a violet filter, and, photograph (4) is taken with infra red filter. Note the difference or details in these photographs. A simple measurement of the diameters of the two images show that the violet image is larger than the infra-red image. Another interesting feature these photographs is that the poles are more prominent and bigger in dimension in the violet image than in the infra-red image. Photographs (1) and (2) are the photographs of San José, in violet light (1), in infra red light (2). They show the same difference of details. (From photographs by Wright).

PHOTOGRAPH AND DRAWING OF MARS

Fig. 9. Photograph and drawing of Mars made on the same night. Observe that they agree very roughly in the general shape of the dark areas. But none of the canals which are clearly shown in the drawing are revealed in the photograph. (From infra-red photograph and drawing by Trumpler).

covering the planet. A study of the variation of brightness with phase suggests that the surface is rather smooth, with no high mountains or deep valleys. But it may be possible that there are plateaus (or level lands at comparatively high altitudes) and low lands with considerable difference of elevation which escape observations. The inclination of the planet's equator to the plane of the orbit is very nearly the same as the earth's and therefore we may divide the Martian surface in the same climatic zones as the earth's two frigid zones round the poles extending 25°, a torrid zone extending 25° each side of the equator and two temperate zones north and south of the torrid zones. We may expect also the same kind of succession of seasons as we experience on our own planet. The Martian day consists of 24 hours and 37 minutes, nearly the same as the terrestrial day, and the Martian year is composed of 687 days, nearly twice our year. In all these respects Mars bear a strong resemblance to our planet. A telescopic observation reveals interesting details of the Martian surface. Apart from the generally red-coloured areas, there are some dark regions of greenish shade and white caps at the poles. The reddish areas suffer no seasonal change, whereas the dark areas, suffer regular changes with season and lie mainly in the tropical region of the planet forming a complete dark belt round it. It was formerly supposed that the dark areas were vast sheets of water and in the older charts these were called 'oceans' and the lighter areas 'continents' from analogy to terrestrial oceans and continents. It is, however, now known that dark areas are not tracts of water, for in the first place, if these were really oceans, then they would behave like great mirrors. Terrestrial observers may, therefore, expect to witness a brilliant reflection of the sun in these dark areas; but such an image has never been observed. Secondly, there are conspicuous details in the dark regions, and this is not possible unless the so-called oceans are so shallow as to exhibit the fine details of the bottom. And thirdly, the colour of these dark areas suffer considerable change with the change of season, this being closely related to the change in the sizes of the polar caps. It was Miraldi in 1719 who first discovered these white caps at Martian poles- but Herschel was the first to examine these in great detail and compare them with the polar caps on our globe. He observed that "the bright polar spots are owing to the vivid reflection of light from frozen regions." He soon discovered that these caps were not fixed features on the surface of Mars, but were very greatly influenced by changes of Martian seasons. With the advent of winter in one hemisphere, the polar cap on it grows in size and the maximum size may even cover half the area from the pole to the equator. The dark areas lose to a great extent their darkness and delicate details and even little patches of *yellow* 'island' may be formed. But with the advent of spring, the polar cap begins to shrink in size and by summer it may be only five hundred miles in diameter; the dark areas are now more conspicuous and darker in colour. Little before autumn, white materials begin to be deposited at various parts near the pole and these are soon absorbed in the expanding cap. A very curious phenomenon is observed when these caps melt. They are found to be bordered by a bluish ring a fact which readily suggests that 'temporarily *sea or marsh*' are in formation by water from the melting ice or snow. The nature of the white material forming the polar caps is very probably actual snow or frozen water. It cannot surely be solid carbon dioxide as has sometimes been suggested for the latter volatilises under a pressure and a temperature much lower than that believed to prevail on the Martian surface. The difficult point in this theory is that the temperature of the polar cap is about 70° C, and it is very difficult to explain how ice can melt into water or sublime into water vapour at such low temperature. We can explain this, however, by supposing that this low temperature is the temperature of the outer surface of the layers of clouds or rather finely divided particles, as will be seen later, enveloping the cap and the temperature is much higher underneath. The behaviour of the darker areas with seasonal change is explained by some by considering them to be tracts of vegetation whose growth and colour would evidently be influenced by the moisture in the atmosphere and the water flowing down from the poles to the equator. The reddish parts have been suggested to be deserts and stretches of barren unproductive lands.

Another theory due to Arrhenius supposes that the soil of the dark regions is full of some soluble salts which with water form a dark coloured mud while in the dry state the surface may be yellow. Parallel examples of this kind of darkening of the colour of the surface by the absorption of water are known on the earth, though the presence of oxygen makes it more probable that there is, actually, some kind of vegetation over the surface of Mars. Apart from the permanent markings a large number of fine uniform dark lines crossing the ruddy surface were observed, as we have already mentioned, by Schiaperelli in 1877. He found also that some of these lines were double like the parallel rails in a railway. In 1892 Pickering found that the crossing points of these lines were marked by dark dots, and that these lines could be observed in the dark areas as well. But the existence and form of these lines are still a matter of controversy. According to Lowell " these lines are *very narrow* (about 15-20 miles), *very dark, perfectly straight* lying with rare exceptions along great circles over the planet's surface and of *uniform breadth and intensity*, though under poor atmospheric conditions they may appear as hazy streaks. These lines form a complex net-work often meeting at dark points." On the other hand Barnard " working with some of the greatest telescopes, never observed these fine geometrical lines, though he observed sometimes ' short ', diffused hazy lines running between several blackspots and two long parallel hazy streamers."

We shall now look into the reasons for this remarkable divergences in the reports published by observers working on the minute details of the surface features of this planet. It is a well-known fact that unequally heated air moving in the line of sight of the observer causes objects seemingly to quiver. The amount of quivering of the objects would, depend on the amount of irregularities of density of air column contained by the eye. The air column contained by the unaided eye is evidently smaller than that contained by the lens of the telescope. The twinkling of a heavenly body as seen with the naked eye will therefore seem to increase when it is viewed through a telescope. Similarly, the images obtained in telescopes with greater apertures are more unsteady and flickering than those obtained in telescopes with relatively smaller spertures. Images of Mars, in a like manner, obtained in telescopes are flickering and consequently the minute details could be seen only when the image is momentarily steady, and the observer has to built up his impression from these momentary visions. This unsteadiness is relatively small with telescopes of twelve or eighteen inches aperture whereas it is very great with telescopes of twenty-four inches or forty inches aperture. It is, therefore, relatively easier to observe these finer details with telescopes of 12″ aperture than with the giant telescopes of 40″ aperture. This is one of the chief reasons why observers like Lowell and Pickering using telescopes with smaller apertures have observed these canals and Barnard using some of the greatest existing telescope have denied emphatically the existence of these delicate details. But resolving power of the telescopes of smaller apertures is very small and this is why the canals have been reported by Lowell to be almost regular and uniform to a geometric precision. All the minute irregularities or hazy streaking character of these canals are suppressed in smaller telescopes and this is supported by the fact that some observers have reported that under exceptional good conditions of seeing *i.e.*, when the air is remarkably still -the images of Mars in larger telescopes reveal the canals as " fairly broad and somewhat irregular streaks." Our largest existing telescope, on the other hand, is not large enough to delineate the real nature of these finer details of the Martian surface and it is hoped that when the 200″ reflector will be complete, it may be put on Mars with advantage. Until then the nature of these canals must remain a mystery to us. Leaving aside the question of faults with the instruments used, there is also a personal factor that creeps in all visual observations and recordings. Different observers working with the same telescope observing the planet under the same conditions of seeing may record the surface details in very different fashions, as happened actually in the case of Lowell and Pickering. We may give another example, "Deslоge drew the canals as straight streaks, but found some very wide and, under the best seeing, resolvable into a mosaic of intricate details, and most of them diffuse, though a few in the best moments appeared as fine, straight, sharp, dark lines. He never saw

a canal double, though his assistant did, with the same telescope and on the same night, and a collaborator 500 miles away independently confirmed the assistant's observations." Russell has in a masterly way explained away this strange phenomenon. He writes, "Between the formation of the image of a faint marking on the retina of the eye and the conscious perception in the mind of a definite pattern which the hand proceeds to draw, there intervenes a process of extreme complexity, most of which is performed subsconsciously and probably depends very largely upon the observer's previous experience and training. As Newcomb has pointed out, the telescopic image of a sharp marking cannot for optical reasons, be as sharp as the marking itself, and the experienced observer learns to correct his judgment of this effect by a process of visual inference which sinks below the level of consciousness........One man's mental apparatus may therefore report a faint line as straight, continuous, and uniform, unless there are bends, gaps, or irregularities in it sufficiently prominent to be definitely seen, while another's may refuse to report a marking as straight and narrow unless it is undeniably so. The same principle evidently applies to the convergence of several lines to the same point, and to the whole question of the existence of geometrical figures on the planet's surface."

We may now enquire if photography could yield any satisfactory evidences of these canals. It is only possible to photograph the real image of Mars obtained in a telescope and even when using the Mt Wilson Tower Telescope with a focal length of 660 ft. Mars in the most favourable opposition will give an image in a photographic screen only an eighth of an inch in diameter. With the Yerkers refractor the image is only one tenth of an inch in diameter. This image may be enlarged by means of enlarging lenses,—but the corresponding faintness of image then becomes a serious hindrance to observational works. Another very serious disadvantage is that the grains of the emulsion of the photographic plate are not fine enough to record saisfactorily the delicate details like the fine thread-like canals. Another serious drawback in these photographs is that the plate records only " the average conditions during the seconds of exposure ". The eye however can wait until it receives the momentary visions of these delicate details and gradually build up an impression. The existence of these canals can never be satisfactorily proved by photographic evidences. However, broad hazy faint markings have been obtained in some exceptionally good photographs but these are too rough and unsatisfactory to give any idea of the more delicate details on the Martian surface.

Observers who have seen these lines report that they suffer the same succession of seasonal changes as the dark areas. They become prominent when the polar caps melt, those nearer the pole darkening first. This rate of drakening proceeds at the rate of 50 miles per day from latitude 70° and continues in the opposite hemisphere to another 1000 miles. In winter, however, these lines decrease in darkness and may even sometimes disappear. As to what these canals actually are we can only speculate. The followers of the vegetation theory led by Pickering explain these lines as artificial canals conducting water from the poles to the equator at the rate of 50 miles per day. As they believe in the geometric character of the lines, they think it very improbable that such intricate arrangements could rise from natural causes. Further, as it is difficult to explain how water could flow along the same canal in opposite directions with change of season they assume that there are highly intelligent beings on Mars who control these canals with remarkable engineering skill. It is further assumed that there is great scarcity of liquid water on the Martian surface, the greater bulk of this water being mainly concentrated at the poles. Considering such a great natural adversity the inhabitants of Mars have been believed to evolve out this elaborate and complex scheme of circulation and proper distribution of water to prevent the slightest waste of this precious substance. It may be true that these lines are not actually canals but " strips of vegetation bordering water courses crossing the arid regions, just as the valley of Nile would appear to an observer on moon like a *great streak* across the yellow African desert." The assumption goes so far as to make us believe that the Martian inhabitants have established a new type of federaed world civilizaion, for the canals are supposed to form a single unit extending from pole to pole. There are other equally plausible

theories regarding these canals. For example, Arrhenius regards "the canals as *cracks or fault lines* in the planet's crust, along which the surface has been stained by escaping vapours, or as *rift valleys* bounded by such *faults*, like the valley of the Dead Sea or the rift-valley in East Africa". Lau observes that these canals are permanent surface features, the variation of darkness that is observed with these canals being due to the variation of transperancy of the planet's aerial envelop with the change of season. Thus the atmosphere becomes very hazy in spring obscuring thereby all the delicate details of the surface and as summer advances the atmosphere gradually clears out revealing progressively these canals and other surface features. This progressive clearing out of the atmosphere, he supposes begins near the poles and advances gradually to lower altitudes, and to an observer this is manifested as a wave of darkening advancing from the pole to the equator. The vegetation theory depends mainly on the geometrical character of the net-work of these lines -and as this is a disputed fact and may be after all due to the personal equation in the observer, we cannot say with certainty whether any intelligent being exists on Mars but it is very probable that some kind of vegetation does exist on this planet. Turning to the question of existence of an atmosphere on Mars, the evidences in favour of a Martian atmosphere are:

(1) *behaviour of the Polar Caps*

The shrinking and redeposition of the white material at the caps suggest that they exist in vapour state in the atmosphere.

(2) *Twilight Arc*

If Mars is examined between the position of superior conjunction and the greatest elongation, it is found that the distance from the terminator to the opposite limb is greater than the theoretical value, a fact which shows that more than half of the planet is illuminated. This indicates, as we have seen before, the existence of an atmosphere on a planet.

(3) *Occasional Appearances of Fog, Clouds or Hazes*

Apart from the regular seasonal changes, the visibility of the surface details of Mars undergoes occasional irregular changes almost from night to night and this variation is explained only by assuming the formation of and clearing up of clouds or hazes in the Martian atmosphere. This has also been verified by photograph observation from time to time of the luminous spot found just beyond the *terminator* in the dark region of the shadow of the planet. A similar phenomenon has been observed on the moon the difference being that, in the latter case, the spots are permanent due to the presence of mountains, whereas, on Mars they are transient, lasting for a day or two. This shows conclusively that the spots in the Martian shadow are high lying clouds illuminated by the glancing rays of the sun while all below is in shadow. The altitude of the clouds has been calculated in the same manner as for a lunar mountain and may vary between 15 to 20 miles.

(4) *Infra-red Photography*

Comparison of two photographs taken in infra red and violet light respectively yields a very striking evidence of the existence of an atmosphere on this planet. In the former we get a greater wealth of detail and high contrast whereas in the latter the planet seems to be of dull uniform intensity everywhere and devoid of any detail whatsoever except in the exceptionally bright polar caps. The reason for this strange behaviour will be clear if we bear in mind that Mars like all other bodies in the solar system is visible to terrestrial observers by means of the sun light, consisting of radiations of different wavelengths, reflected by it. The penetrating power of infra red radiation is far greater than that for violet radiation, for the scattering power is inversely proportional to the fouth power of wavelength. Hence, while ultra violet light is intercepted and scattered by the upper atmosphere, infra-red light penetrates through it and illuminates the Martian surface, exposing its details in the photograph. A photograph of this planet with yellow filter will be intermediate between the infra red and ultraviolet photographs in richness of details and constrast. It will also be more or less a faithful reproduction of what actually an observer views when he peeps through his telescope. Apart from details and contrasts, a comparison of these photographs will reveal certain other interesting results. If Mars is supposed to

possess a fairly extensive atmosphere, then there must be an appreciable difference of diameters of the images recorded in these photographs. The radius of the image in the photograph taken with violet filter must be the radius of the image in the photograph obtained with infra red filter plus the height of the Martian atmosphere. The researches of Wright have revealed that above premises are true and the violet image is definitely larger than the red image. It is also possible to calculate the height of the Martian atmosphere by noting the difference of the radii of the images in these photographs and according to Wright this must be about 60 miles. This height is about one-half of the height of our atmosphere, which may be calculated from the observation of the meteors.

There is another interesting result which Wright observed in his violet and infra-red photographs. At his time of observation it was winter in the northern hemisphere of Mars and he observed a great difference of the size and brightness of the polar caps in these photographs. In the violet photographs this cap was found to be bigger and much more prominent than that in the infra-red photograph. This fact became more striking as the Martian spring advanced in the northern hemisphere, when the white caps entirely disappeared from the infra red photographs but in the violet photograph they were still sufficiently prominent. This leads us to think the white cap in the violet photograph was not totally a surface phenomenon whereas the white cap in the infra red photograph must have been a genuine surface feature. The pole must, therefore, be enveloped by something which reflects back the violet radiations strongly but is transparent to infra red radiation. This envelope further must not merely consist of gas molecules since in that case polar cap would not be exceptionally bright. It cannot consist of clouds of water-vapour since these are opaque to infra-red radiation, but must, as Wright has suggested, be a haze of finely devided particles floating in the atmosphere. The cap at the south hemisphere, where at the time of observations summer had advanced, appeared to be really a surface feature.

We have not yet considered the composition of the Martian atmosphere. The value for the velocity of escape suggests that the planet will retain all the heavy gases like O_2, N_2, CO_2 and water-vapour, and not the lighter gases like H_2 and He. Spectroscopic observations reveal the existence of slight traces of oxygen and water vapour. Recent researches of Adams and St John in 1925 indicate " for equal areas the water vapour on the surface of Mars.... was of the order 5 per cent and the oxygen of the order of 15 per cent of that normal in the earth's atmosphere."

Though the height of the atmosphere of Mars is found from infra red photography to be about half that of our atmosphere, it does not follow that the pressure of the Martian atmosphere should also be half of the terrestrial atmosphere pressure. The acceleration due to gravity is much smaller on the Martian surface than on ours and consequently weight of the same mass is much less on that planet. It has been estimated that the Martian atmosphere is exceedingly rare, the pressure being only half as much as that due to our atmosphere at the summit of Mt Everest.

Radiometric measurements of temperature by Lowell show that Mars is quite a chilly planet. The temperature of equatorial regions at noon is 10° C (50° F) while it falls below 0 C at sunrise and sun set. The nights are generally very cold.

From what we have discussed above about Mars we cannot be quite sure regarding the presence of any animal life on the planet and we can safely follow Russell in passing a verdict of *not proven* regarding the romantic theory of vegetation of Mars as put forward by Lowell.

The redness of the surface indicates that it is largely composed of ferric rocks. On the earth, the rocks are mostly ferrous, but it is a well-known fact that oxygen of the atmosphere is being slowly but steadily absorbed by the ferrous rocks and this process is irreversible. Probably even on the earth, after several millions of years, most of the oxygen of the atmosphere will in this manner be absorbed and thus lost. If Mars is in this stage, as seems probable, we are witnessing there the end of the drama of Life. In Venus probably it is only beginning and on the earth, it is in a mature state.

Jupiter

Jupiter is the biggest of all the planets of the solar system, its mass being 316.94 times that of the earth. Its density is very low being only 0.242 times that of the earth and the albedo amounts to about 0.42. The vast magnitude of the planet and the large value of the velocity of escape indicate that it contains a very dense atmosphere and has been able to retain all the elements including hydrogen even after its separation from the sun. The high value of the albedo shows that the planet is enveloped by very thick layers of clouds. The rapidity of motion of the clouds led to the belief that the temperature of the surface is very high although it may not be so high as to render the planet visible by its own radiation as in that case there would not have been complete disappearance of satelites during eclipses. If the planet self-luminous even to a very small extent, the satelites would continue to shine by the light radiated from Jupiter even when they were completely hidden by the latter planet from the sun. Coblentz found that the temperature of the upper layer of the clouds is as low as 140°C which is nearly the temperature which the planet would have, had it been warmed by solar radiation only. Consequently the upper layers of the clouds reflect only solar radiation and very little heat comes from the interior of the planet. We know very little about what is below the thick layers of cloud enveloping completely the whole of the planetary surface. The very low density of the planet suggests that the central core is still very hot and may be even in a gaseous condition. The age of Jupiter is perhaps of the same order as that of the earth; and it is very difficult to explain why Jupiter has not yet cooled to a hot liquid nucleus separated from the gaseous layers by a solid crust. In 1924, Dr H. Jeffrey rejected all the older traditional ideas about Jupiter being an intensely hot gaseous body like the sun ana put forward an entirely new theory which explained why the planet had such low temperature as revealed by the radio-metric measurements and have at the same time such a low density. "By mathematical reasoning taking account of the low average density of the planet and certain other mechanical ideas involving the dimensions and shape of the planet" he suggested that the nucleus has cooled to a dense rocky material which is surrounded by a very thick layer of ice which again is covered by an extensive atmosphere. But we have not yet got any definite idea about the nature of the planet's interior parts. Spectroscopic observations have on the other hand, given very accurate indications as to the nature of the constituents of the cloudy atmosphere of Jupiter. The spectrum is in general that of the reflected solar radiation, but there are intense absorption bands in the red and the orange parts, evidently owing their origin to the atmosphere on Jupiter. For a long time the nature of these bands was not clear. They were sometimes attributed to water-vapour sometimes to oxides of nitrogen. In 1932 Wildt demonstrated that they are due to methane and ammonia. This identification was confirmed in 1933 by Dunham who recognised 60 lines of ammonia and 18 of methane. A measure of the intensities of these lines showed that the amounts of ammonia and methane in Jupiter's atmosphere measured under normal conditions of temperature and pressure should be respectively 10 meters and 180 meters thick. It is possible that the clouds of Jupiter consist of liquid drops and fine crystals of ammonia and methane (ammonia freezes at 197.5°K and methane at 89°K) suspended by dust particles floating in an atmosphere of the same gases mixed with nearly all the permanent gases like hydrogen nitrogen etc., at higher altitudes the clouds may consist of liquid drops of these permanent gases. We may therefore conclude that the conditions as they prevail now on the surface of Jupiter cannot support life but more definite knowledge about the interior of the planet may some day change our views.

Saturn, Uranus, Neptune, Pluto

It is not necessary to consider these planets individually in detail, for they resemble Jupiter very closely. Their temperatures are much lower and the atmospheres are more extensive and dense. In some of them ammonia is absent, which may exist in solid state. As for the existence of any life on these planets, we may draw the same conclusion as for Jupiter.

This brief survey that we have made of the various planets of the solar system contains nearly

all that is known, at present about their habitabi This question of habitability of planets will co to puzzle the scientists for a long time to come. We may imagine that our descendants, equipped with greater vision and understanding, will take up this problem again. They may seriously think of inter planetary voyages and, suitably equipped, they may move from planet to planet to verify directly if extra-terrestrial life exists. As for the rest of this endless universe outside the solar system, our present state of knowledge and the present equipments at our disposal do not permit us to search the vast celestial space for living beings. But there is apparently no reason why among the millions and millions of stars, some doubtless possessing a planetary system similar to ours, our little planet should be the only abode of living creatures. Summarizing, we can say with some emphasis about the solar system, on the basis of what little science has, at present, revealed to us, that smaller bodies like Mercury, moon and the asteroids can have no life on them. Jupiter and the outer planets are far too cold for any kind of habitation. As regards our neighbouring planets, Venus and Mars we have not yet arrived at any definite indictaions of life. Finally we have to admit with reluctance and disappointment that the place which seems to enjoy the exclusive privilege of supporting life in this entire solar system is our rather small and insignificant planet with a long history behind it through which life has marched from the simplest algae to the greatest outcome of evolution the homosapien or the modern man.

Promotion of Soil Studies in India*

MODERN soil science requires for its promotion contributions from several branches of science and soil studies offer a vast field of research for workers in pure science. The need for advancing the knowledge of Indian soils is indeed great and obvious.

The foundation of the Imperial Council of Agricultural Research has given a great impetus to agricultural studies in their various aspects, including soil studies. A good beginning has been made. But it is necessary to emphasise the magnitude of the effort that is required in order that soil science can play its proper part in contributing its share to our economic well-being.

What we require most urgently today is a realisation on the part of our statesmen and of our universities of the immediate and ardent necessity of putting soil studies on a sufficiently broad and stable basis. A soil takes a long time to grow. Through interaction with natural factors and through interference by man, soils undergo changes which are often slow. If not carefully watched and remedied in proper time, these changes may lead to a deterioration or an exhaustion of the soil and even to its total loss. Instances of both are numerous in India. Moreover, any useful knowledge of soils requires considerable time and resources for its collection. Considering the vastness of India, the wide range of climatic conditions and of the variations of our soils and the slow nature of soil changes, it is obvious that we have to begin immediately on a very extensive basis if we hope to obtain within a reasonable span of time any demonstrable improvement of practical nature. The magnitude of our efforts should be commensurate with that of the task before us.

In his illuminating and authoritative report on the work of the Imperial Council of Agricultural

*From the Presidential Address delivered by Prof. J. N. Mukherjee at the Annual Meeting of the Indian Society of Soil Science, on January 4, 1939 at Lahore.

PROMOTION OF SOIL STUDIES IN INDIA

Research Sir John Russel has recommended, among others, the setting up of a Soil Conserv tion Society, whose functions would cover extensive studies of soils. He has also made other recommendations regarding the way in which the work now being done by the Imperial Council should be consolidated and extended. Apart from the activities of the Council, there are other aspects in which soil studies require to be promoted. Firstly, in a country like India, where agriculture is the mainstay of a very large majority of the population, a '*soil-sense*' should be created. The *ryot* has such a sense but, useful though his knowledge is, it is gained empirically. There is no reason why a certain degree of familiarisation with local soils should not be incorporated in our training in elementary science at the high school stage. There should also be a larger number of efficient agricultural schools attached to demonstration farms, where farmers in general will be given facilities to acquaint themselves with modern methods of cultivation and soil management suited to their needs and resources. There are, even today, many provinces *e.g.*, Bengal, Orissa, Assam, where there are no agricultural colleges, and any scheme for the improvement of agriculture for the introduction of improved methods and increased facilities for training in agricultural practices must remain handicapped for the want of properly trained men. The number of experimental stations, their equipment, both in men and apparatus, are far from being adequate. Most of the existing experimental stations run by Provincial Governments have very little opportunity, on account of inadequate facilities in this regard, of making their proper quota of useful contributions. Agricultural schools of a more advanced type should be established, working in close association with colleges teaching science subjects. In most European countries the volume of contribution to useful knowledge regarding local soils and agricultural practices made by such schools is not inconsiderable. If existing resources are utilised judiciously and are supplemented, the cost to Governments should be within their means. Very few of the universities have any direct relation with agricultural studies and research. The departments of revenue, irrigation, agriculture and education seem often to work in watertight compartments without a pooling of the resources and co-ordination in their activities so far as soil problems are concerned. With the transfer of power to a wider electorate, the question of proper assessment of land revenue on a yield basis is bound to engage increasing attention. Full utilisation of available land constitutes one of the major problems. And an increasing population desiring for better amenities are bound to press these problems more and more on the attention of provincial Governments. It cannot be said that we are making the best use of our lands or preventing their exhaustion on a wide scale or reclaiming waste lands wherever feasible. In some provinces, *e.g.*, Bengal, problems of land reclamation in the deltaic area are intimately connected with sanitation, drainage, irrigation, and water transport. In all these matters a good deal of scientific knowledge of a highly technical character must be garnered before a proper solution can be achieved. Partial solutions suggested by a body of experts, not directly concerned with soil studies may constitute a sheer waste of effort and money and may even lead to disaster. The universities unfortunately do not seem to have realised how important it is for them to provide the highest type of training, including training in research in the basic sciences on which all improvements in agricultural practice ultimately depend. Soil science, plant genetics, entomology and microbiology of soils should find a recognised place in the science faculties of the universities. It should be possible to encourage these studies without incurring excessive financial commitments by bringing them in close association with the departments of pure science, such as, chemistry, botany and zoology. The University of Dacca, at the initiative of Prof J. C. Ghosh, has already taken steps in introducing a course of studies in soil science. It should be possible to have research departments dealing with agricultural problems in the universities working in close association with the provincial experimental stations.

These are the broad lines along which educational activities might be directed for the promotion of soil studies in the country. Until recently soil studies have not received that amount of attention which its importance deserves. The number of trained men, who are devoted to or are in a position to take up soil studies will barely exceed three dozens in the whole of the country. The urgent need, therefore, is to train up men specially in

research methods; for we must have a reliable body of scientific knowledge of our soils before we can have any beneficial practical results. How little is known about our soils is best illustrated by the comments of Schokalsky, who undertook the preparation of a soil map of India at the instance of the International Society of Soil Science, where she laments that even the very meagre data on Indian soils, which are available, are not of much value for useful scientific purpose.

We have not yet got any satisfactory knowledge of the major groups of Indian soils and of their relation to the world groups. Far less do we know of the variations within each of them and the manner and directions in which they are changing. Apart from the practical considerations it is necessary to mention that the study of soil science should also be encouraged purely for its own sake. An over-emphasis is often laid on the need for the promotion of the applied sciences. The neglect of pure science, which is after all the mainspring of all fundamental scientific discoveries, can only dry up the stream which sustains applied science. It is true that practice in applied sciences, prompted by considerations of immediate gain, sometimes but not quite often, outstrips the developments in its basic scientific knowledge. But practice, not based on pure scientific knowledge, will soon deteriorate into empiricism and rule of thumb methods till science can again put practice on stable foundations. It is, therefore, absolutely necessary that soil studies should be primarily based on their contents of scientific enquiry and should be guided so that both basic knowledge and practice of applied science can march together. It is from this point of view that encouragement of research and training in research methods cannot be relegated to the background. Apart from the activities of Governments and of Universities there is another source, from which help can be sought in the promotion of soil science. If one tries to analyse the causes responsible for the backwardness of soil studies in India, one finds that the ignorance and poverty of the cultivator and the laws of inheritance leading to subdivision of holdings are, perhaps, to a large extent responsible for this situation. Under such conditions the most feasible way to improve agricultural condition must consist in an improvement of varieties and in extending irrigation facilities. For the *ryot* who is not in a position either to gather for his own use knowledge regarding current improvements, nor has the capital to utilise such knowledge, can always be helped with better seeds and with an improved supply of water for his crops. Attention has, therefore, in the past been specially concentrated on these two points. In contrast to this, if we take the case of the soils used for tea cultivation, where services of science and capital have both been commanded, we at once see the difference. It is, however, a matter of great regret that big landholders and the middle class, who are in a position to requisition the services of both of these, have played an inconsiderable part in the improvement, amelioration or reclamation of land. If properly planned, such schemes should bring an economic return. Such schemes are also closely related to the problems of middle class unemployment. The problem is to induce educated youths, having land of their own and some capital to take to the land. The best way to induce them is by a practical demonstration by the Provincial Governments of possibilities of success for such a career. Under the inspiring leadership of the late Sir Fazli Hussain, the Punjab Government have taken in hand schemes of colonisation of land by educated youths. The progress of these experiments is being watched with the keenest interest all over India, and we hope, that such experiments broad-based on scientific knowledge of soils and crops will achieve the desired end. A body of gentlemen farmers serve to exert a very healthy stimulus to agricultural departments and experimental stations. By virtue of their knowledge, position and economic necessity they would constantly endeavour to utilise, confirm or reject the conclusions of the official stations which concern their interests.

Absorption of Salts by Plants*

B. N. Singh

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In a study of the mineral nutrition of a plant there are many factors which must be considered, for the intake of nutritive elements involves complex chemical and physical processes. It has become evident during recent years that the absorption and accumulation of elements by the plants in course of their normal nutrition, involves processes which may easily escape proper study in so far as most investigations on permeability of cell membranes are concerned. The investigator of the permeability of plant cell is often constrained to employ highly artificial environmental conditions (high concentration of solutes, use of solutes foreign to the cell, unsuitable conditions of light or aeration etc.), or to work over very short periods of time. Investigations of such a nature have their own limitations and hardly serve to elucidate the gradual intake of electrolytes by the growing or actively metabolizing plant. Much work has been carried on, covering several years, on the intake of certain more important elements and it is now definitely indicated that of all elements potassium has been universally found at a concentration in the cell sap much higher than that in the external solution. The evidence collected during the past several years on the absorption of this element by apparently closely related and similar species and varieties of crop plants, chiefly, of the Gramineae, when grown in culture media of similar mineral constitution, indicates how widely the rate of asbsorption differs with the variety, and in certain cases with the individuals as well of the same. Evidently highly generalized statements with regard to the physical-chemical properties of the different chemical elements in relation to their intake by plant cell must be made with caution.

* An account of a discussion on this subject, in which the writer took part, edited by Prof. P. Parija is being printed in the *Proc. Ind. Sc. Cong.* Vol. IV.

Among the factors that vitally determine the absorption of salts from liquid media, the aeration of the solution has been shown to be most important. While conducting a series of very carefully controlled studies on the absorption and accumulation of certain elements, it has been definitely shown that the respiratory activities of the root cells are indispensably involved in the process of accumulation. Significant differences in the rate of absorption in different varieties of the same plant did not occur except when the medium was suitably aerated. Under conditions of proper aeration favouring optimum respiration of the delicate rootlets and root hairs, striking differences were obtained. In all these experiments aeration of solution did not merely carry away the carbon dioxide evolved by the roots, but also supplied oxygen for proper respiration. Maximum accumulation of electrolytes was attained under those conditions which provoked maximum aerobic respiration of roots. Excised roots of these very plants, too, show but little or no power to accumulate electrolytes under non-aerated conditions whereas under proper aeration, seedlings accumulate these ions very rapidly. In all such cases it has also been marked that the metabolic state of the roots as determined by culture conditions existing previous to excision is also of great importance.

The reaction of the solution is another important factor in the absorption of salts. Investigations in this regard have shown that for each species and variety of the crop plants there is a specific range of pH at which optimum absorption takes place. Toxicity is more likely to occur, if in spite of other favourable conditions, the acidity of the sap is not maintained within certain range of the optimum for the species.

Light has particularly been shown to influence the intake of K and N ions. With increase in either the intensity or the duration of artificial illumination

it has been found that wheat plants grown in water culture accumulate more of these ions. Above a certain range of intensity and duration the reverse effect is clearly noted. This indicates how a purely external factor influences the absorption of the simple inorganic entities.

Temperature of the medium too introduces significant differences in so far as the total quantity of solutes absorbed by the plant is concerned. Thus in three series of cultures of wheat grown at 45°, 35° and 30° C respectively it has been shown that the total ash content after a period of 45 days increases with the increase in the temperature of the culture from 30° and 35° C and later exhibits a marked decline. This optimum temperature was found useful for all studies on absorption.

Humidity of the atmosphere has also been found to greatly regulate the intake of solutes from the soil but it cannot be said with certainty whether it has any direct effect on the intake of solutes. When grown in an environment with humidity above 75%, wheat plants failed to absorb as much of nitrogen from the medium as under relatively drier atmospheres (50% humidity). Such vaiations in the absorption rate are correlated with the transpiration values under the two conditions but it cannot be vouchsafed for the present that the evaporation of water from the plant has any direct bearing on the rate of absorption of ions.

Of special interest in this connection is the relation between the intake of solutes and the metabolic needs of a growing plant. The data collected in this connection indicate that in the majority of cereals and a few other plants, the absorption of soil constituents is characterized by three distinct phases, co-extensive with the more important stages of vegetative development. The first of these covers a period of progressively increasing rate of absorption ending about the time the head begins to form. At this time it is frequently observed that the absolute amount of potassium and nitrogen contained in the plant approaches the magnitude present at complete maturity. The beginning of the second phase is indicated not merely by a decreased rate of absorption but by definite and substantial losses of certain constituents notably potassium, nitrogen and calcium from the portions of the plant growing above the ground and presumably from the entire plant. The loss is more or less concurrent with the migration of the same constituents into developing heads. The end of the second phase is characterized by a tendency to absorp again the soil constituents previously lost. This may result in taking up considerable quantities of these elements when the plants are large and well developed. The third phase occurring at the time of the ripening of the grain is marked by a practically complete cessation of absorption of all constituents and an actual loss of most of them.

While such cyclic variations in the absorption rates of certain elements characterize different species and varieties of plants experimented upon, it may incidentally be remarked that, specially in soil and sand fertilizer cultures, the losses of potassium and nitrogen at certain stages of the life-cycle occur when the constituents of the water extract of the soil were at or approaching their minima and when the same constituents were moving from leaves to the heads. Much, however, depends upon the specificity of the plant material, the specific needs of the plant at various stages of growth and development, and the relation which the process of absorption might have with other metabolic activities of the plant.

Attention may specially be recalled at this stage to the characteristic relation between the age-factor and rate and order of absorption of ions on the one hand, and the relation between the intake of certain elements, specially potassium and calcium, and the photosynthetic efficiency of plants on the other. While the ions in case of one single species are not absorbed at the same rate and in the same order at successive stages, there does seem to exist some correlation between the quantity of these absorbed and the specific metabolites. Thus a higher rate of absorption of potassium and calcium has always been shown to be associated with a higher rate of photosynthesis and *vice versa*.

The phenomenon of the relative intake of nutrient elements from culture solutions is further complicated by the antagonism between different ingredients, the unequal absorption of component ions and the selective absorption of these ions by the species under consideration. In considering this aspect, however, we cannot but take into consideration the quality and state of protoplasm more

ABSORPTION OF SALTS BY PLANTS

particularly the amphoteric nature of plant proteins, the biochemic constitution of the species, and the nature of the particular stimuli-physical, chemical or mechanical, the effect of which is being investigated.

The whole question, as a matter of fact, remains yet to be carefully analysed and unless large amount of comparative data under different conditions and stimuli, specially from water culture experiments, sand water cultures, soil-pot cultures, field experiments and so on, and under as many different combinations of factors as are practicable, are available it is rather difficult to arrive at any definite generalization. Strictly controlled experiments with a parallel study of the different plant processes directly bearing upon the question of absorption of salts might also aid in solving the still little understood processes connected with the intake of ions by plant. It is also desirable to call attention to the extensive investigations of Mason and Maskell. They suggested that re-export towards the roots of certain element *via* the phloem may have a bearing on the rate of absorption of such an element by the root cells. The relation or lack of relation between transpiration and absorption of mineral elements is also thought to be involved. The absorption of these elements may then involve problems of plant anatomy as well.

It has further been demonstrated that while the absolute amount of solute absorbed by the plant increases with increasing concentration of the solute in the external solution, the amount absorbed relative to the external concentration nevertheless decreases rapidly from the lowest concentration upwards. When the external concentration of solute is low the absorption rates become more than unity, while under high external concentrations, the absorption rates are always less than unity.

The degree of absorption depends not only on the concentration of the external solution but also upon the nature of ions absorbed. Thus the absorption of nitrates cannot be considered independently of the absorption of cations in as much as their effects on such plant characteristics as protein content of wheat are concerned. The quality of protein is known to vary with the character of the culture media, the nature of heterogenous salt supplied, and particularly the concentration of the nitrate ions in the medium, as expressed by the result of extreme conditions of no nitrate on the one hand and ample quantities of nitrogen salts on the other.

Summarising the whole question it may be remarked that the mechanism of living cells involved in the absorption of salts, which is undoubtedly of exceedingly great intricacy, has not yet been disclosed through any direct experimental approach, although we have before us many of the suggestive explanations of the phenomenon put forward by various workers from time to time. Among the theories advanced during the past few years, mention may be made of the ionic exchange theory of Brooks and Briggs, Osterhout's conception of undissociated molecules entering the root cells, Brazealess's theory of physical absorption, the *epictesis* theory of Lapique etc. The conception of a simple Donnan equilibrium is too inadequate to explain the phenomenon of ionic intake since the interior of plant tissues is known to comprise a number of phases each of which may be in Donnan equilibrium with the external solution and under which circumstance, product of the apparent internal ionic concentrations resulting from the total effect of all these pha es is shown to be greater than the external product. Not entering into the relative importance of these results and others, each of which have their own limitations, it may be of use to remark that studies on the absorption of salts by plants grown on natural soils, particularly those yielding good crop, have important application in investigations for determining the conditions for optimum growth by means of sand and water cultures; for while the amount of a given constituent absorbed does not necessarily indicate the quantity essential for proper development, fluctuations in the rate of absorption may be expected to reflect at least to a certain extent, the nutritional peculiarities of the crop and serve as a guide in regulating the concentrations and amount of solutes at successive stages of growth.

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Archaeological Work in Swat and Afghanistan

In a lecture delivered before the Royal Society of Arts, London, Evert Barger, lecturer in medieval history in the University of Bristol, described the results of the recent archaeological expedition to Swat and Afghanistan. The expedition was undertaken in the hope of providing fragments of evidence bearing on the problems of chronology in the study of the Buddhist art of Gandhara, the country which lay between the Indus and the Hindukush. Evidence of the influence of Gandharan art has come from various Central Asian sources, extending so far as Chinese Turkestan, there being only one blank—Bactria and the Oxus territory. The expedition turned their attention to this territory, spent the summer months of 1938 excavating in the valley of Swat beyond the Indian frontier and later made an archaeological reconnaissance of the unexplored territory in the north of Afghanistan covering a distance of 2000 miles.

In the Swat valley a complete survey was made of all the Buddhist ruins, and a map was prepared showing the remains of *stupas,* monasteries and fortresses and also of villages and terraced cultivations. Khanjar Khote, one of the typical monastic sites excavated consisted of a main courtyard in which a stupa stands, surrounded by stupas following no fixed plan and probably built at different times. From these small stupas were recovered a few pieces of blue schist showing scenes from Buddha's life in relief, a few plaster heads and pieces of broken decorations. At Amluk, a solitary site on a mountain top was discovered masonry of unfamiliar pattern and the finds consisted of a 3 ft. seated Buddha of 'late' variety. The circumstances in which the sculptures were found suggest destruction by Mohammedan invaders rather than slow decay.

Later, two members of the party starting from Kabul crossed the Hindukush into the Oxus plain where a large number of mounds were examined. At Kunduz was discovered an impressive round castle with walls more than a hundred feet high and half a mile in circumference which was probably a seat of the Sassanid kings ruling over Bactria. On one site were found carved bases of Greek columns disproving the contention of Foucher that Hellenistic cities of Bactria were built of mud or sun-dried brick. When the archaeological finds, discovered as a result of this expedition, will be compared and properly studied we may be somewhat nearer to the solution of the difficult problem why and how such a virile hybrid art sprang up in a small area on the Indian frontier and spread to Afghanistan and Chinese Turkestan.

The Cultural Influence of the Cinema

The League of Nations Advisory Committee on Social Questions has recently issued a report on "The recreational Cinema and the Young." It discusses among other things the frequency and the effect of the attendance of the young people at cinema theatres, protection from unsuitable films, juvenile taste in films and special performances and special films for juveniles. Interesting accounts of activities of the Governments of the U. S. S. R. under the last heading are given. Their "Children's Cinemas" are equipped on broadly conceived lines as recreationery centres and includes in addition to the theatre, large halls for games and musical programmes, library and reading room and a cinema museum where exhibits illustrating the history and technique of cinema production are displayed. Children are encouraged to amuse themselves before the performance begins, the programmes being so arranged as to prepare them for understanding the film about to be shown. A special staff of teachers is employed in these cinemas. The Central Department for Industrial Cinematography employs a regular staff for the making

of films for children, the subjects including travel and exploration, animal life, lives of great men and works of popular children's authors.

Chilean Earthquake

A severe earthquake rocked several parts of Chile on January 25, the shock lasting several minutes. A huge area extending from Talca in the north to Los Angeles in the south was affected and several small towns were completely destroyed. 30,000 persons are reported to have been killed and 50,000 injured, the total damage being estimated at one and half million pounds. This earthquake evidently ranks among the most destructive shocks the world has experienced this century. The country, being a peculiar maritime shelf between the mighty masses of the Andean mountains and the sudden great depths of the Pacific Ocean, lies in one of the most active seismic belts of the world and earthquake shocks here are almost as frequent as in Japan. Even in Calcutta, situated at a distance of 11,000 miles, practically on the opposite side of the globe, the shock was recorded by the seismographs as one of great intensity. People of this country have recent experience of a great earthquake's havocs and horrors, and will feel much sympathy for the Chileans in their sufferings.

Development of Wireless Communications

The *Wireless World* of December 29, 1938 publishes an interesting survey of the developments of 1938 in Wireless telegraphic and telephonic communications. Last year at the International Telecommunication Conference held at Cairo, an important step forward in the growth of these communications was made by adopting an arrangement of distribution of specific frequencies amongst the various services, *e.g.*, air service, broadcasting, amateur service, etc. During the year, telephone communications were established between life boats and the English coast stations. These are expected to supersede the previous practice of broadcasting of navigational and gale warnings by telegraphy. The *Queen Mary* herself was able to communicate with the land *via* the coast stations and also with British Cross-Channel passenger ships via the Rugby-Baldock route when she was hundreds of miles out on the Atlantic run. Considerable progress was also made in collecting weather reports from ships at sea for weather forecasting service. More than 10,000 such reports were received during the past year at the coastal stations. One of the most important functions of the wireless navigational service, is to provide bearings to aircraft and during the year no less than 60,000 bearings were given to more than 200 British airships. Arrangements have also been completed to hold communications with the trans-Atlantic airmail service which will start this year from the station at the Foynes air base. The most striking progress has been made in the realm of the ultra-short waves. About a dozen of ultra-short wave services are now in operation in England. The use of crystal controlled oscillators both in the transmitters as well as in the receivers, which are of the superheterodyne type, maintain remarkable stability even in the region of these ultra-short waves. This has enabled reliable ultra short wave services to be installed at a number of stations to maintain communication amongst themselves. In view of the approaching maximum of solar activity a new receiving station is under construction in England where there will be special arrangements for combating the effects of sunspot activity. There was an important development on the telegraph side regarding the Empire rates. As a result of an agreement between the Cables and Wireless Ltd., on the one hand and the Government concerned on the other hand, flat rates per word were introduced for all messages within the Empire.

Prof. E. V. Appleton, F.R.S.

H. M. the King has approved the appointment of Prof. E. V. Appleton as successor to Sir Frank Smith as the Secretary to the Committee of the Privy Council for Scientific and Industrial Research. Prof. Appleton has been Jacksonian professor of natural philosophy in the University of Cambridge since 1936, before which he was Wheatstone professor of physics in the University of London during 1924-36. He is best known for his valuable original work in the investigation of the ionised regions of the upper atmosphere and their influence on the propagation of radio waves. The results of his work have enhanced our knowledge of the physics of the upper atmosphere and also have been of great assistance in the development of long distance radio-communication.

The appointment of Prof. Appleton to this responsible position indicates how the British Government unhesitatingly requisition the services of *'pure'*

scientists possessing ample experience and vision, to take over the charge of directing the state policy in the matter of scientific and industrial research. In India, the wisdom of such a policy has not yet been felt by the Governments and members of the administrative services often wanting in the necessary outlook and having a tendency to be wrapped up in mere routine work, are placed in charge of departments of the Government which have to undertake planning and carrying out of scientific and research programmes, though such work could be more profitably entrusted to competent and experienced scientists with broader out-look. In fact, the policy of the Government of India in appointing gentlemen administrators to positions which should go to genuine scientists, has resulted in the multiplication of file work, whereas the country needs field and research work.

Industrialization in India

Sir Thomas Ainscough, H. M. Senior Trade Commissioner for India, Burma and Ceylon, in his report on conditions and prospects of United Kingdom trade in India, 1937-38, maintains that on account of the policy pursued by Government departments with the object of fostering production, there has been considerable contraction of the Indian market as a ready outlet for overseas manufactured goods. In 1936 and early 1937 there was an industrial company promotion boom, the results of which will be apparent in the contraction of imports of articles that will be locally produced when the new factories come into production. Of the major protected industries, the Indian cotton mills last year increased their production of cloth by over 500 million yards to the record figures of 4,084 million yards. The contraction in import from United Kingdom will be apparent from last year's figures of 267 million yards as compared to 1,456 million yards in 1928-29. As regards iron and steel, the import figure has come down to 374,000 tons as compared to 1,170,000 tons in 1928-29. Within a few years the total steel production of India is expected to reach a million tons a year and will practically meet the whole of the Indian demand with the exception of a few specialities. India is also rapidly becoming self-supporting in the supply of galvanized sheets. She now produces all her railways equipments with the exception of locomotives, wheels and axles. Imperial Chemical Industries Ltd., have this year formed a special Indian manufacturing company to produce soda ash, caustic soda and chlorine and one or two Indian concerns are also turning their attention to heavy chemicals. Indian paper, cements, sugar, matches, agricultural implements, electric fans, glass ware, copper sheets, certain types of electric cables, pharmaceutical and medical supplies, disinfectants, etc., are gradually displacing the imported article. Prominent Indian industrialists are seriously considering the early erection of works in Bombay to manufacture medium-powered motor cars and commercial trucks. The company will begin by assembling and gradually extend local manufacture. Another prominent Indian industrialist has been considering offers from machinery manufacturers for a modern works to produce textile machineries. The production of oil and steam engines has begun and will be extended. A company has been recently started in Calcutta for the manufacture of simple machine tools, while the Tata Iron and Steel Co., have advanced plans for the manufacture of heavy chemicals and fertilisers on a large scale. Yellow metal and copper sheets are being rolled in India, aluminium utensils have been produced for years and a large scale plant for the output of aluminium from Indian bauxite is projected.

Sir Thomas sounds a note of warning to Indian public men, both politicians and industrialists, and points out that if the policy of maximum industrialization be followed in India it will lead to a serious clash of interest with the large agricultural population, to a crisis in the finances of the Government of India owing to large curtailment of customs receipts and to a collapse of the financial and economic fabric of the Government of India which depends upon an excess of balance of exports in order to meet India's financial commitments in London. At a time when the regeneration of national industries in India has just commenced and initial steps are being taken for national industrial planning, these remarks with all their implications have got to be seriously considered. The above point of view, however, will not stand a moment's scrutiny and will be found to be unduly alarmist and absolutely untenable. The transitions from an economy based mainly on the export of raw materials to one based on a more balanced distribution between agriculture and industry may cause only temporary difficulties and maladjustments. The progress of industrialisation on the other hand will largely benefit agriculture and agriculturists in India. The sugar and textile industries have been of much

assistance to agriculture by providing market for sugar cane, cotton and jute. Starting of new industries will create demand for new raw materials much of which may be raised by our agriculturists. The Agriculture and Famine Commissions from time to time have deplored the undue pressure of population on land in India and have suggested alternative means of employment through establishment of industries. A steady equipoise between agriculture and industry in India would be beneficial for both and is essential for her full development. With the progress of industrialization leading to expansion of wealth and raising of the standard of living of the people, the country will continue to purchase more goods rather than less from British and foreign markets though probably of a different variety and kind. There is hardly any justification for the fear of fall of receipts of the Government of India as that will be partly compensated by the rise in the revenue from the income-tax paid by the industrialists and from customs duties on new kinds of goods imported from abroad.

Safety in Coal Mines

Sir Mohamed Zafarullah Khan has introduced a Bill in the Central Legislative Assembly whose objective is to ensure safety in coal mines. In general the seams worked in Indian collieries are relatively thick and the so called "Pillar and Stall" system of working are adopted. Experience has shown the importance of leaving large coal pillars to support the superincumbent strata, though thereby entailing loss of the coal left behind in the mines. In times of bad trade there is a great temptation to extract coal from these pillars giving rise to serious mining accidents. To overcome the possibility of such danger and at the same time to recover the solid coal left as pillars a few Indian companies have adopted the method of packing the voids by hydraulically stowing them with sand. As mentioned in our editorial article of this issue, the Coal Mining Committee set up by the Government in 1936, to enquire into the methods of extracting coal in Bengal, Bihar and C. P. and to report on the measures which should be taken to secure the safety of the workers and to prevent avoidable waste of coal, have strongly advocated the adoption of hydraulic sand stowing. There are Government regulations laying down conditions under which coal is to be extracted and Government supervisory authority to see that these conditions are fulfilled. But there has been uptil now no provision for ensuring that the space left by extraction of coal should be filled in where the absence of such filling is likely to result in fall of roofs leading to fires and explosion. These recommendations of the Committee have been examined by the Government of India in consultation with the Provincial Governments and representatives of the Industry. Those who have studied the problem are satisfied that adequate sand supplies are available in the Damodar river for the requirements of the Jharia coal fields. The only difficulty seems to be that stowing being an expensive process, without some form of co-operative effort it may be financially impracticable. The Government Bill is designed to meet this need. We hope legislative measures will be passed without delay to enforce sand stowing in coal mines in India so that safety in the working of such mines may be ensured.

Necessity of Drug Legislation in India

To prevent the huge traffic in adulterated and spurious drugs, which is a grave menace to public health and welfare in India the Drugs Enquiry Committee set up by Government of India under the chairmanship of Col. R. N. Chopra in 1930-31 stressed upon the necessity of passing suitable legislation on an all-India basis. Since then leading members of the medical profession and the industry concerned have persistently urged the necessity of putting a stop to this growing menace. The Government of India introduced a Bill in the Legislative Assembly in 1937 which was applicable only to imported drugs but later it was withheld and the Government announced their intention of proceeding with a more comprehensive legislation applicable not only to imported but also Indian manufactured drugs. Similar legislations are already in force in all advanced foreign countries. In the United Kingdom there is the Food and Drugs Act, 1928, dealing with the manufacture, importation and sale of food and drugs and Therapeutic Substance Act, 1925, for controlling the therapeutic substances. In U. S. A., there is the Federal Food and Drugs Act which controls both the drugs and therapeutic substances. The Indian Chemical Manufacturers' Association has submitted a draft Bill to the Government which aims at controlling the manufacture, importation and sale of all drugs and medicines including therapeutic substances such as sera, vaccines, etc.

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Among the more important provisions of the Bill here is a demand for the establishment of a Drug Control Board consisting of experts, manufacturers and medical practitioners so that expert technical and commercial advice and guidance would always be available to the Government in the matter of framing rules and regulations prescribing standards of purity, strength etc., of drugs and medicines and issuing of permits for imports of drugs. The Association also urges the necessity of taking early steps for compiling an Indian Pharmacopoeia which would lay down standards for all drugs and medicines used in India, and the enactment of an All-India Pharmacy Act for training, education and registration of pharmacists which would go a great way in helping to check the sale of spurious and worthless drugs. The principles of the Bill submitted by the Chemical Manufacturer's Association should receive careful consideration of the Government.

Royal Asiatic Society of Bengal

Sir David Ezra in his presidential address delivered at the last annual meeting of the Royal Asiatic Society of Bengal drew attention to the multiplication of scientific societies at a rapid rate in this country and remarked that each new society or institute created represented a decrease of support for the Asiatic Society. This also has raised the awkward question: has an institution like this, based on the universal programme of study of all that pertains to Asia, and of which "even today about three fourths of the members are dilettantes, and only one fourth specialists", a valid biological function to perform in our modern times? In the past the Society has been fruitful in generating a series of scholarly bodies and institutions of a specialized nature and it has always generously and unselfishly aided these bodies. It helped the foundation of, and administered the Indian Science Congress Association and published its proceedings and it still houses the National Institute of Sciences of India, in addition to maintaining relation of an intimate and important character with institutions like the Linguistic, Zoological and Geological Surveys of India, the Zoological and the Royal Botanical Gardens and the Indian Museum. The President throws out a dark hint that as a result of the number of special societies increasing rapidly it may not be possible to keep up the old programme of scientific activity of the Society and the Society may have t de necessity of restricting itself more and more to purely orientalistic studies. But increasing tendency of specialisation mak d not be necessary and vital, the existence of som o ordinati body to take a general view of the work in many specialised fields and we feel that a reorganization of the Society's functions rather than restriction of its scope as hinted by the President, should be contemplated. We do not agree that the Society should degenerate into a Club for fashionable rich men as another Asiatic Society in another part of India has done; but it should be a rendezvous of scholars of all types, and thus fulfil the functions for which it was founded by the first founder President, Sir William Jones.

Botanical Survey of India for 1937-38

The annual report of the Botanical Survey of India for 1937-38, which has been recently issued, shows that there has been a growing realization of the importance of indigenous Indian plants for industry and medicine. Information regarding the sources, properties and uses of various economic plants and plant products was supplied to numerous correspondents in India and abroad. Detailed information regarding possibilities of cultivating a large number of medicinal plants indicating the localities in India where they could be experimentally tried has been supplied to the Director of the School of Tropical Medicine, Calcutta, and some of his assistants were allowed to continue their work in the Sibpore Herbarium in connection with the investigation of medicinal plants. University professors and workers in other scientific institutions in India and abroad were supplied with information on economic plant products and authentic materials for their research work were procured for them.

Under the auspices of the Imperial Council of Agricultural Research, an enquiry was started to investigate the possibility of bringing fresh areas under cultivation with a view to increasing the production of Cinchona alkaloids in India. The results of this enquiry are expected to be out before long and will be awaited with interest.

The work in the Sibpore Herbarium continued on usual lines and the Herbarium was enriched by the addition of some rare specimens received from Kew and Edinburgh, and also from Japan, China and Java.

A large number of original papers and two books dealing on Botany of India were published during the year by specialists and researchers in India and abroad.

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Indian Statistical Conference

"Without the help of statistics man today would wander aimlessly through the perplexing universe, uncertain and inefficient, as any forethought and design would have been impossible. In collecting facts, statistical analysis discloses casual and other stringent connections between related facts. Such study is at the basis of all sound human endeavour. No schemes to solve questions of unemployment and poverty, or optimum living under a given set of circumstances are likely to possess validity without the aid of your scientific apparatus." With these words the Hon'ble Mr. Manohar Lal welcomed the delegates at the second session of the Indian Statistical Conference held at Lahore in January last under the Chairmanship of Dr. T. E. Gregory, Economic Adviser to the Government of India. Sir Henry Duffield Craik, Governor of the Punjab, in opening the session paid a warm tribute to Prof. P. C. Mahalanobis for the services which he has rendered to the country in laying the foundations of a systematic study of statistics. Referring to the importance of statistical study of the vital problems facing this country Sir Henry said:

"The adjustment of man's numbers to the resources which he is able to extract from his environment is fundamental to his well being, individual and social. Hitherto such adjustments have been affected mainly by the blind working of natural forces at a great cost in human suffering. The changes, which in the space of less than 100 years transformed England from an agricultural country into a modern industrial state, were carried through unplanned and almost unperceived. No statistician was at hand with a mass of carefully tested and selected figures to advise or warn. But now we have conceived the idea of controlling or even planning economic and social changes, and India, which today visualises with hope and expectancy the possibility of transforming herself from a poor agricultural country into a wealthy and semi-industrialised state, may perhaps be thankful that this transformation has been so delayed that the modern science of statistics is available to guide its execution. May she have wisdom to equip herself so that this science may be availed of to the full." We wish for greater and continued success of the Indian Statistical Institute in its endeavour to apply more and more statistical methods in the study of the manifold problems connected with national welfare.

Announcements

Dr Muhammad Qudrat i Khuda, Mr I. G. H. Ariff, Dr Prafulla Chandra Ghosh of the All-India Village Industries Association and Mr J. H. Burder of Messrs. Jardine, Skinner & Co., (nominee of the Bengal Chamber of Commerce), Dr B. C. Roy (nominee of Calcutta University) and Mr Fazlur Rahman (nominee of Dacca University), have been nominated members of the Industrial Survey Committee recently appointed by the Government of Bengal. The first list of members appeared in our issue of December.

Dr William Filchner, the famous German Explorer who was awarded the German National Prize by Herr Hitler for his magnetic survey of Central Asia has recently arrived in India. After visiting the Observatory of the Survey of India at Dehra Dun he will go to Nepal to begin his work of magnetic survey which will occupy several years.

At the last Annual Meeting of the Royal Asiatic Society of Bengal, the Bruhl Memorial Medal was awarded to Sir David Prain, late Director, Royal Botanical Gardens, Kew, and the Joy Govind Law Medal to Dr B. Prasad for conspicuous contributions to the knowledge of Asiatic botany and Zoology, respectively.

Dr S. Parthasarathy has been awarded a Fellowship by the Nobel Institute of Stockholm and has proceeded to Sweden to carry on research work there.

The constitution of the Bengal Industrial Research Board, which will be an advisory body, has been announced. The main functions of the Board will be to advise the Industries Department in matters relating to industrial research, to co-ordinate existing work and to indicate new lines of research and to endeavour to secure the active co-operation of the universities and technical institutions; The members, whose term of office will be for two years, are the Director of Industries, Bengal; Prof. P. N. Ghosh; Prof. J. C. Ghosh; Dr W. G. Macmillan; Mr E. S. Abdulkader; Mr J. N. Lahiri; Mr A. L. Ojha; Dr A. Karim; Mr J. N. Sen Gupta; Dr R. L. Dutta.

SCIENCE IN INDUSTRY

The Planchromat: a new microscope objective

A new microscope objective, the planchromat, has been produced in the laboratories of Carl Zeiss in Jena, after a long period of research. This objective gives equal sharpness in definition throughout the whole field of vision and is a distinct improvement upon other types available uptil now. With different types of microscope objectives now in use, if the spot at the centre of the field be sharply in focus, the field would become increasingly blurred towards the edges. Sharpness of definition at the centre of the field at the expense of that at the surrounding area was preferred to the equalized but lessened defintion everywhere. This difficulty has been done away within the new type of lenses and at present the new lenses are available in different magnifications.

New Luminous Signs

Neon signs which are commonly displayed consist of glass tubes containing the rare gas at low pressure fitted with two metal electrodes at the ends. All the letters are combined and the intervening tube between the letters are coated with an opaque paint. Due to the use of high voltage the tube is insulated from the main body of the sign by keeping it several inches apart.

In a new system of tube-lighting recently devised, each individual letter in the sign is formed separately and consists of a tube filled with gas and provided with small glass extensions. No electrodes or other electrical connections are employed. The tubes are placed against the sign or against any other surface, in which is mounted a radio frequency power supply. The power supply is connected to energizing strips which are embedded in the surface of the sign behind the luminous tubes. These strips are metallic conductors, encased in glass, which radiate the energy directly to the gas contained within the letters. A great advantage in this is that the letters are interchangeable. This new type of luminous letters consumes kW. for a single row of letters of a marquee sign displayed in the cinemas.

Synthetic Glycerine

Glycerol, produced as a by product of the manufacture of soap from fats, has become so important in the manufacture of synthetic resins, particularly those used in paints and enamels, that its synthesis is being undertaken to amplify the supply. A successful process of synthesis has been discovered which consists in chlorinating propylene, a by product of cracking of petroleum and hydrolysing with alkali the trichloropropane thus formed. One of the large oil refining companies has already installed equipment for this purpose and expects to be able to produce glycerol at a fraction of its present price.

Scientific American.

Electricity in aid of Digestion

The *Scientific American* of January, 1939, reports a method and equipment for introducing soft-curd characteristics into milk by the application of sonic energy high frequency virbrations. Cow's milk nowadays is modified by various expedients to give a more readily digestible curd. The apparatus used to apply the vibrations to milk consists of a stainless steel diaphragm approximately two feet in diameter which is vibrated electromagnetically at a frequency of 360 vibrations per second. A stainless-steel cover is provided, which can be bolted against the diaphragm, thus forming a chamber. The milk to be treated is introduced into this chamber through the inlet opening at the outer edge of the cover and in order to pass out of this chamber must of necessity flow over the centre of the diaphragm where it is subjected to intense vibra

tion before passing out through the centrally located outlet opening in the cover. The unit is capable of handling milk at the rate of 250 gallons per hour with a power consumption of approximately five horse-power.

New Paint Tester

At present, the technique of testing the durability of paints consists, generally, in exposing the paint panels prepared under standard conditions in a standard disposition. The disadvantages due to the variability of natural weather and the slowness of the process of deterioration in this method have been overcome by the Megger Paint Tester (Digby and Patterson Patent) which was recently exhibited by Evershed & Vignoles Ltd., in the 29th Exhibition of the London Physical Society at the Imperial College, South Kensington. With the deterioration of the paints and other coating materials the compositions which may be considered as impermeable membranes become permeable. The testing apparatus, taking advantage of the phenomenon, determines the comparative values of the paints by measuring the rate of decay of the osmotic or electrosmotic resistivity of the paint membrane in a few hours. The apparatus consists of a cell or number of cells connected to an indicating or graphic recording ohmmeter. The cell is of moulded insulating material and is made in two halves, each containing a carbon electrode. The test piece consisting of a layer of filter paper coated on both faces, or impregnated, with the paint, is placed between the two halves of the cell, which are then bolted together, a water tight joint being made by two rubber rings. The two compartments on each side of the test piece are then filled with a conducting solution and electrical tension is applied between the two carbon electrodes, the resistance being measured on the ohmmeter equipment is provided with socket connections for ten cells and a jackboard so that readings from each cell may be taken at periodical intervals. A recording ohmmeter can be inserted in the place of the indicating ohmmeter if continuous observation is required on any particular cell. The rate at which deterioration takes place can be varied by the nature and strength of the solution on each side of the paint membrane. This apparatus has given valuable information regarding the temperatures and times of stoving of insulating varnishes and also about the relative values of insulating cloth.

— *From the Electrician.*

Manufacture of Motor Vehicles

In these columns we have recently discussed about the automobile industry and its possibilities in India. For reasons easily understood, foreign manufacturers do not favour the proposals. Our readers are aware of the growing alarm of the British manufacturers recently voiced by Sir Thoman Ainacough in his review of the United Kingdom trade with India in 1937-38.

Recently, Mr D. E. Gough, the Indian representative in Bombay of the General Motor Traders and Manufacturers, Limited, of London, has issued a statement in which he invites attention to a report of the Australian Tariff Board which expressed itself as opposed at present to the manufacture of complete motor cars in that Commonwealth.

In the same circular, Mr Gough, invites attention to the scheme for the manufacture of automobiles in India put forward by Sir M. Visvesvaraya, whose opinions were largely quoted in our columns, and states that most of the conditions which induced the Australian Tariff Board to form its opinion are equally applicable to India and concluded with the view that in India too it is "better to buy than build."

Sir M. Visvesvaraya has pointed out in a press statement that in tabling the Tariff Board's report in the Australian House of Representatives, the Minister of Customs, Mr White, said "The Government adheres to the policy of encouraging the establishment of an industry for the manufacture of engines and chassis in Australia. The Government invites prospective manufacturers of engines and chassis, or parts thereof, to submit their proposals, with details of the assistance required. Consideration will be given to any proposal for complete manufacture."

Voicing popular opinion, the *Australian Manufacturer* observed in support of the above statement that "the project would be at once a valuable addition to our industrial activities and an important element in our national defence. A fixed and stable tariff policy will, in the end, attract to these shores what may well be described as the greatest of modern industries."

Bihar Electricity Project

The Technical Committee appointed by the Government of Bihar to examine the Bihar electrification project consider that the electrification of parts of south Bihar and Chota Nagpur is feasible and they

recommend that the Government should take steps as early as possible to provide that part of the province with electric power and so provide "the one great commodity lacking for its industrial and further agricultural development."

They suggest that there is a sufficient load already visible or in prospect to justify an installation of a 30,000 kW steam generating station with transmission lines covering that area of the province comprised roughly in the area between Purulia and Ranchi on the south and the Ganges on the north. Initially, one generating station only should be established (preferably in the coal-fields if sufficient water for a large steam power station is available) and the initial stages of the project should be laid out to admit of enlargement of that station up to 50,000 kW, and the transmission system should be so designed as to carry the current generated in this station and another of the same size when required. For the purpose of preparing a definite scheme and of subsequently giving effect to it, a highly qualified technical staff should be appointed at as early a date as possible. In a recent issue we published an article on Bihar Electrification Scheme (SCIENCE AND CULTURE, 3, p. 426, 1938), where the author discussed the feasibility of hydro-electric generation project in the province.

Paper Manufacture from Indigenous Products

A collection of interesting exhibits of paper samples manufactured from *Bambusa sp.* from Munj (*Saccharum Munja*), from Ramsar (*Saccharum arundinaceum*), from Ulla Grass (*Anthistiria gigantea*) and from Sabai or Bhabar Grass (*Ischaemum angustifolium*) have recently been acquired from the Forest Research Institute, Dehra Dun, and exhibited in the Public Gallery of the Industrial Section (Botanical Survey of India), Indian Museum. Another instructive exhibit of commercial importance, which has lately been added, is a sample of 4·2 lbs. of paper manufactured from 10 lbs. of air dried bamboo culms. The process of manufacture and the treatment of various chemicals in different stages of manufacture from the raw material to finished paper has also been shown. This process is as detailed below:

Ten pounds of bamboo treated with 15 ozs. of Sodium Sulphate and 1 lb. of Lime produces 4·5 lbs. of unbleached paper pulp which when treated with 9·5 ozs. of bleaching powder gives 4·2 lbs. of bleached paper pulp, then again treated with 4 ozs. of China Clay, 1 oz. Rosin, 0·125 oz. of Soda Ash and 1 ozs. of Alum gives 4·2 lbs. of finished paper.

Glass from Reh

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The chief raw materials used for the manufacture of glass in India are sand, lime and soda-ash. The first two suitable for glass manufacture, occur in various parts of India, while for soda ash, the industry has to depend totally on foreign countries. The price of soda ash available in India is many times higher than that of the sand or limestone, it being Rs. 110 per ton. Consequently, the cost of an average glass batch is increased manifold. Attempts have been made in the past in foreign countries to utilize rocks which are rich in alkalis as a partial substitute of soda ash and many such attempts have been successful in Russia, Italy etc. The present paper also contains attempts towards this direction and some of the trials have been successful.

The material aimed to act as a partial substitute for soda ash in the manufacture of glass is Reh. In India Reh is found in the pleistocene deposits of the Gangetic alluvium. It is a peculiar saline efflorescent product found covering the surface and destroying in great measure its agricultural fertility. The Reh salts are a mixture of carbonate, sulphate and chloride of sodium together with calcium and magnesium salts

derived originally from the chemical disintegration of the detritus of the mountains, dissolved by the percolating waters and then carried to the surface by the capillary action in the long dry weather. It varies in chemical composition from place to place and it has been observed that usually one found in the United Provinces, is rich in carbonates and that in Behar is rich in Sodium Sulphate. It has been estimated by Mukerji and Watson that about 7,321,000 tons of crude soda contaiaing about 4,888,000 tons of Na_2CO_3 could be obtained annually from the available deposits of Reh. In fact the U. P. Govt. started a factory in 1917 to manufacture Na_2CO_3 from Reh. The process was found to be commercially successful although the factory was closed for some private reasons. The deposits of Reh, unfortunately are not found in any continuous beds. They are found in patches of various dimensions, here and there but the supply is regular and continuously replenished.

Round about Benares the Reh is found in sufficient quantity so as to make it a commercial proposition. Investigations were made to utilize these Reh deposits as a partial substitute of soda ash in a glass batch. Its behaviour in the course of glass fusion and the quality and quantity of substances necessary to facilitate the formation of glass mass while avioding bubbles, viscous glass and other defects were studied.

A typical glass batch used by the Indian glass factories is made up as follows:

Raw Material.	Weight in maunds.		Wiegnt of oxide in	Rate per maund Rs. As. P.	Rs. As. P.
Sand	100	SiO_2	100 mds.	0 6 0	37 8 0
Lime (Slacked)	14	CaO	10.6 mds.	0 10 0	8 12 0
Soda Ash	40	Na_2O	23.4 mds.	3 9 0 (after refund of customs duty)	142 8 0
Total	154		134 mds. Glass		188 12 0

The composition of this gla

SiO_2	74.6
CaO	7.9
Na_2O	17.5
TOTAL	100.0

and the cost of the average batch to produce one maund of glass works out to Rs. 1/6/6 and of this Rs. 1/1/ *i.e.* 75%, of the total cost is the price of soda ash alone. To reduce the cost of glass batch appreciably, it is absolutely necessary to reduce the quantity of soda ash, and to substitute it partly with Reh.

Chemical Analysis of Reh

A number of different samples of Reh from different patches from a Benares locality were analysed and it was found that the constituents were variable to certain extent. These gave the following composition:

SiO_2 ..	66.00 to 71.80%
Al_2O_3 ..	11.80 to 12.44%
Fe_2O_3 ..	0.21 to 0.26%
CaO ..	2.98 to 3.36
MgO ..	0.62 to 0.84%
Na_2O ..	7.80 to 9.20%
K_2O ..	2.54 to 6.60
Loss on ignition	1.23 to 2. 5

The best sample from the various deposits was air dried at 110° C for about 3 hours and on analysis it was found equivalent to:

SiO_2	70.80	
R_2O_3	12.00%	Al_2O_3 and Fe_2O_3
RO	3.68%	CaO and MgO
R_2O	12.80	Na_2O and K_2O

A number of glass melts were made using this Reh in increasing quantities. The glasses were melted in 1 lb. pots in an oil fired furnace at a temp. of 1350°–1400°C. The parent glass chosen was:

SiO_2 ..	72.00%
RO ..	6.00%
R_2O ..	18.00%
B_2O_3 ..	1.00%
	100.00%

and in each successive melts 1.5%, of SiO_2 was replaced by 1.5%, R_2O_3 and this amount of R_2O_3 was solely derived from Reh which at the same time introduced some quantity of SiO_2, RO and R_2O oxides and the remaining amount was made up by the addition of pure sand, lime and soda ash.

Nos	Glass Composition.	Batch.	Cost per md	Melting and working properties of the glass.
1	SiO_2 73.5% RO 6.0% R_2O 18.0% R_2O_3 1.5% B_2O_3 1.0%	Sand 64.65 Reh 12.50 Lime 7.32 Soda 28.04 Borax 1.40	Rs. 1-5 3 (The price of Reh Sand are taken as As. 6 per md.	Very clear glass, soft, melting. The glass had faint green colour and could be decoloured with pyrolusite.
2	SiO_2 72.0% RO 6.00% R_2O 18.0% R_2O_3 3.0% B_2O_3 1.0%	Sand 54.30 Reh 25.00 Lime 6.71 Soda 25.30 Borax 1.40	Rs. 1 3 9	Clear glass, soft melting. Glass is greenish in colour and could be decolonised with pyrolusite.
3	SiO_2 70.5% RO 6.0% R_2O 18.0% R_2O_3 4.5% B_2O_3 1.0%	Sand 43.95 Reh 37.50 Lime 6.10 Soda 22.57 Borax 1.40	Rs. 1 2 3	Clear glass melting in four hours and fining in two more hours. The glass was greenish in colour and with pyrolusite the colour was reduced to a very faint green.
4	SiO_2 69.00% RO 6.0% R_2O 18.0% R_2O_3 6.0% B_2O_3 1.0%	Sand 33.60 Reh 50.00 Lime 5.49 Soda 19.82 Borax 1.40	Re. 1 0 9	Clear glass melting in four hours and fining in 2½ hours. The glass was more greenish than no. 3, but quite suitable for medicinal bottles.

Nos.	Glass Composition.	Bath.	Cost per md.	Melting and working properties of the glass.
5	SiO_2 67.5% RO 6.0% R_2O 18.0% R_2O_3 7.5% B_2O_3 1.0%	Sand 23.25 Reh 62.50 Lime 4.89 Soda 17.10 Borax 1.40	Re. 0 15 4	The glass was a little darker in colour and also more viscous.
6	SiO_2 66.00% RO 6.0% R_2O 18.0% R_2O_3 9.0% B_2O_3 1.0%	Sand 12.90 Reh 75.00 Lime 4.28 Soda 14.36 Borax 1.40	Re. 0 13 11	The glass was very dark in colour and very viscous and not suitable for blowing.

From the above six representative batches it becomes clear that No. 4 batch is ideal for manufacture of glass bottles, and that Reh can easily be used as a partial substitute of soda ash. The iron content of Reh gives a greenish colour to the glass, and this is not undesirable for bottle glass.

By using Reh as a part substitute of soda ash to the extent shown in No. 4 melt, the cost of the typical batch is reduced from Rs. 1 6 6 to Rs. 1 0 9 per maund and so a saving of As. 5-9 per maund of glass produced is effected and this means a saving of 25 % in the cost of raw materials alone. The amount of soda ash required for 100 maunds of glass is 30 mds. and so by the introduction of Reh, the amount of soda ash requirement is cut down by 33 %.

MEDICINE AND PUBLIC HEALTH

Maternal Deaths

As the result of a statistical inquiry into the causes of maternial mortality, lately carried out for a period of one year by the All India Institute of Hygiene and Public Health, it is found that in 96.3 per cent of maternal deaths investigated in Calcutta, there was an avoidable factor present.

Eight hundred and eighty seven maternal deaths were investigated, of which 701 were found to be due directly to child bearing and the remaining 186 to diseases associated with child-bearing. Puerperal sepsis, anaemia and eclampsia stand out as the most important causes of death due directly to child bearing in Calcutta, while pulmonary tuberculosis was responsible for 40 per cent of deaths from diseases associated with child bearing. The importance of anaemia was greater than appears for in addition to those deaths from anaemia *per se*, there were many others, specially in the sepsis group, in which anaemia wsa an important contributing factor. In 161 ante natal and 12 peurperal women examined there were 77 cases of macrocytic anaemia, 41 cases of microcytic anaemia, and 55 cases of normocytic anaemia. Of the 77 cases of macrocytic anaemia only 23 were hyper chromic, the remaining being normo and hypo chromic according to European standards.

Tuberculosis in Mill Areas

A Bengal jute mill with 5,300 workers has been chosen for a long range investigation to ascertain the rural population's reactions to tuberculosis infection in industrial areas. The incidence and character of tuberculosis infection, the nature of dust hazards which cause respiratory or other disabilities, how the disease spreads from the industrial areas to the village homes of the workers, and the degree of hypersensitiveness in them and their contacts, are being studied. Attempts are also being made to trace as many of the tubercular workers as possible to their homes to find out the extent of home infection.

The mill chosen has, among its workers, 3,980 men, 836 women and 483 children hailing from all parts of India, and offers a representative mixed population in diverse conditions of sanitation and over crowding. The mill is the only one in the neighbourhood of Calcutta which has an X ray installation. The data collected for each individual include details of previous illnesses, age at entry, nature of work, duration, financial status and housing. It is proposed to examine a number of new entrants to industrial life and to make periodical tests in order to study their reactions to the new environment. Home surveys will also be made in mill and rural areas in as many cases as possible. The size concentration and chemical composition of the dust in the industry will also be determined

Cultivation of Pyrethrum (Chrysanthemum Cinerariaefolium) in India

The Pyrethrum plant is well known for its valuable insecticide properties and especially for its uses in anti malarial measures. Dwellings may be sprayed with Pyrethrum for destroying adult mosquitoes and oil-lavrvicides may be used as an anti-mosquito measure. The Pyrethrum plant is mainly grown in China and Japan. It has also been successfully cultivated in Kenya. An altitude of 6500-9500 ft. has been found to be suitable for the purpose. Plants grown at lower altitudes give a smaller yield of flower heads thus resulting in uneconomic cultivation. In India, an elevation of 5,000—6,000 ft. has been found to be suitable for its cultivation. The Punjab Government first tried the cultivation at Lyallpur and Murree in 1930. The plants did not flourish at Lyallpur but the succeeded very well at Murree. In Kashmere, it has

been grown successfully near Baramulla at an altitude of 5,000 ft. It has also been successfully grown at Parachinar in the Kurum Valley in the North West Frontier Province at an elevation of 5,000 ft. The Imperial Council of Agricultural Research has been investigating the possibilities of its cultivation in selected places. The seed at most places was sown in July and transplanted during September to December. The month of September has been found to be suitable for sowing in the hills in the United Provinces and during March to May at Murree. It has failed to germinate at Ranchi, Poona and Sind. It is to be hoped that the Imperial Council of Agricultural Research, as well as private workers, will further investigate the possibilities of cultivating Pyrethrum in India.

Transfusion of Stored Blood

In 1930, in the Sklifassowsky Institute, Moscow's big first-aid hospital, Dr Serge Yudin made an unprecedented transfusion of blood into a young man who was brought in nearly dead from shock and loss of blood. Nearly three quarters of a pint of blood was taken from the body of a man, who had been brought in dead with a fractured skull six hours ago; after suitable treatment it was injected into the young man. Two days later the patient left the hospital cured and well. From a dead body one can remove more than three times the blood a live donor can spare. With the official approval of the Ukrainian Surgical Society, Dr Yudin later worked on a large number of cases " without ever having found in any way that the blood from a dead body gave inferior results than the blood of living donors." The technique is now so perfected that the Russian doctor uses it for the routine treatment of all sorts of conditions which need blood. The only difficulty is that the blood must be taken within eight hours of death if it is to remain liquid non-effected and non-poisonous. It must be thoroughly tested before it can be used and these tests however, take considerable time. Dr Yudin has recently found a method of storing the blood instead of using it directly from the body. He keeps reserves in his hospital, reserves already grouped and tested, ready for instant use. Treated with a chemical to prevent clotting and kept at a low temperature, the blood remains good and fluid for periods as long as four weeks. This marks a new scientific advance in emergency treatment, a method to save lives with " the co-operation of patients who have passed beyond the reach of help for themselves."

Discovery.

Spectroscopy in Medical and Biological Research

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Recent advancements in medical research have been conspicuous for the increasing successful application of ideas and concepts from other branches of scientific investigations, particularly from those branches commonly referred to as the physical science. The physico-chemical investigations on biological problems have covered a field of productive research work which has yielded interesting and important results to the medical profession. Radioactive elements, X-rays, colorimetry, spectroscopy, refractive index, hydrogen ion concentration, viscosity, surface tension, elasticity, osmosis and diffusion, photo-electricity are a few of the chapters of the growing branch of biophysics. The spectrograph which has been used for several epoch making discoveries is slowly conquering a place of honour in recent medical researches. In a qualitative way, spectroscopy is used unconsciously by the medical profession for a long time, since whenever one observes a colour one is applying a modified form of spectroscopy. The colours which are emitted are analysed by methods of emission spectrography, and colours which are absorbed, by absorption spectrophotometry. The study of the absorption and emission of light in the visible and the ultra-violet regions gives information regarding the properties of substances, both organic and inorganic, even though they are present in minute traces, as each substance has a characteristic spectrum which can be compared to the characteristic capillary lines of a finger

print. The study of the characteristic spectrum serves as a very useful means of describing and distinguishing an unknown product, and of detecting and even estimating at times the amount present in a biological substance. By this method, it is possible to analyse the residue from a single drop of tap water, with fair accuracy the proportions in which sodium, calcium, magnesium and perhaps two or three other elements are present. It is also easy to ascertain the identity of a drug separated from some toxicological material and also to dertermine the quantity separated even when it is of the order of a 1 1000th part of a milligram. Its contribution to the advancement of a few of the following branches of medical research as haemoglobin, plant pigments, vitamins, hormones, bile acids and sterols, proteins, alkaloids, glucosides, mineral content of foods and tissues, and clinical diagnostic methods, to mention a few, have been so remarkable that it is impossible for one to summarise them in a short article.

Emission Spectrography

By this method, it is possible not only to determine the metallic constituents in any substance, inorganic, organic or biological, but also to do a qualitative analysis as well in such minute traces where no chemical tests would respond. The spectrograph can certainly find a use in public health laboratories as it can be used for detecting lead, mercury, fluorine or other injurious metals present as impurities in water, food stuff and drugs which are consumed by the public. It is recognised that minute, even microscopic, quantities of metals have an important effect on metabolism. Recent advances in chemotherapy have also shown how organic compounds containing metallic radicals have great therapeutic propetries. Deficiency or excess of some metals in the human system causes abnormal physiological symptoms. The need for detection and estimation of minute traces of metallic constituents from very small quantities of tissues or biological fluids has become increasingly imperative. Spectrochemical methods have proved superior to the usual chemical methods which may sometimes fail to give an indication of even the presence of the substance. The spectrograph has been effectively used in detecting, even in the remote tissues of the body, chronic metallic poisioning such as silver in argyrosis, lead in kidneys, aluminium in blood, copper in the cirrhosis of the liver, and various metals in pneumoconiosis. Progress of cancer has been followed by the examination of the tissues for lead with collosol lead treatment. Gerlach and co-workers have made several quantitative analysis by spectrochemical methods on the gold content of tissues in tuberculosis patients receiving gold treatment and found that a large amount of gold is present in the tissues which are tuberculously affected. Researches of Ramage and others have revealed several unsuspected metals in both plant and animal kingdom. Silver and copper have been isolated from mushrooms, the first also from the livers of crabs and lobsters, barium from human choroid, lead from cerebro-spinal fluid and aluminium from the gallstones. In the study of some diseases of the type of aneamia in the sheep in Australia the spectrograph revealed a low cobalt and copper content in the soil, and the disease was prevented and cured by copper-cobalt treatment of the soil and the animal. Burge, on the other hand, found by a spectro chemical analysis that in cataractous lenses potassium was in deficiency whereas calcium was in excess. The high sensitivity of the methods of emission spectra analysis, the speed of working, the extremely small quantity of the substance required, and the ability to simultaneously observe for many metals, all these contribute to the efficiency and success of the method.

Absorption Spectrophotometry

Absorption spectrophotometry has been responsible for some epoch making discoveries in the recent advancements of biochemical researches. In this, we have a precise method for discriminating between different substances and estimating the quantity present in the liquids which undergo a decomposition during separation or extraction. The spectral absorption curves provide characteristic labels for several physiologically active substances, the existence of which rests on biological methods of experimentation. Many substances, which could be assayed only by biological methods or complex chemical methods, are readily identified and measured by their characteristic absorption spectra. Further, resemblances in the chemical constitution can be gathered from similarity of absorption properties. Similarity in the absorption spectra of some vitamins and their derivatives, hormones, carcinogenic substances and some alkaloids show that these compounds are chemically and biologically very much interrelated. In the investigations on carcinogenic substances, synthetic preparation of drugs and the study

of the constitution of several biological substances, the absorption curves have been elaborately used. The various pigments in animal and vegetable kingdom are quickly differentiated and labelled.

The typical absorption curves of ergosterol, vitamin A, carotene, flavine, etc., have helped very much in the pioneering investigations of the very interesting series of compounds known as vitamins, not only in describing and detecting them but also in estimating and studying their constitution. Windaus and others, studying the absorption spectrum of ergosterol found in ergot, rye and yeast, established its identity with the fraction isolated from cholesterol, as the progenitor of vitamin D. Today the characteristic absorption spectrum of ergosterol is used for determining the quantity present in most natural products. The colouring matters of egg white, whey and yeast are identical and this was established by the common absorption spectrum. The isolated substance is a flavine derivative and is called the vitamin B_2. Fish liver oils gave an absorption band at 328 whose intensity decreased with loss of physiogical activity. Subsequent researches have shown that this band is characteristic of vitamin A. The measurement of the intensity of absorption by spectrophotometric methods has been accepted by the League of Nations as the International Standard for assaying vitamin A and has completely replaced the chemical methods and found to be more quick and reliable than the biological method. The Vitameter is a simple visual spectrophotometer which is used for rapidly assaying vitamins A and C. This technique is able to determine with a satisfactory degree of accuracy the potency of not only rich concentrates containing 20 to 100 % of vitamin A but also of butter which contains as little as 0·0004 % of vitamin A. The characteristic absorption band at 328 of vitamin A is used for detecting it in the tissues for researches on the conversion of carotene to vitamin A or in the visual purple of the retina for researches on vision and deficiency of vitamin A.

The α and β band of oxy-haemoglobin is used for routine detection of blood using a reversion spectroscope fitted to a microscope. The absorption bands of haemoglobin derivatives are helping in clinical diagnosis of anaemia and controlling the administration of drugs which in large doses cause decomposition of the blood. The absorption curve helped extensively in the classical researches of Fisher Barcroft and others on the structure of haemoglobin, porphyrins and haemochromogens.

Alkaloids, hormones, aromatic polynuclear compounds, proteins, and purines are a few of the widely varying biological substances which have been a subject of spectrographic research. Absorption methods of assaying some of the compounds, as vitamins, hormones and alkaloids, are gradually gaining ground in preference to the tedious biological methods.

Fluorescence Spectra

The fluorescent lamp in addition to being a quick method for qualitative analysis serves as a check for controlling the purity of the drugs and guards from adulteration by detecting the impurities. Ergot fluoresces blue, digitalin a weak yellowish green, strophantin a bright blue. Aspirin shows no fluorescence while one of its decomposition products fluoresces strong bluish white. The fluorescence spectra of several polynuclear compounds are being used for tracing the presence and passage of these compounds in the biological system. Vitamin B_2 fluoresces bluish green, while vitamin B_1 is oxidised by potassium ferricyanide to a fluorescing thiochrome. The measurements on the intensity of fluorescence using a photoelectric fluorometer are found to be in fair agreement to those obtained by animal experimentation method.

Methods of spectrographic analysis have been of valuable assistance in medico-legal work. The positions of the absorption bands of haemoglobin are used for detection of blood in stains or for carbon monoxide poisoning. Detection of shot wounds by the identity of the spectrum of the tissues with that of a particular cartridge, the identity of the spectra of the smear of the paint in the dress with that in a burgled house, presence of metals in the intestine of the tissues for suspected metallic food poisoning, are a few of the applications of spectrochemical analysis, which have booked the offender. The fluorescence of inks in documents defaced or deteriorated and the study of the finger prints after adding some fluorescent solutions as anthracene, further give recent methods for detection of crime.

It was once accepted that the microscope is the most wonderful single piece of instrument in the hands of the medical researcher. But in recent years it looks as though the spectrograph is slowly conquering a place of honour and is serving as the "Aladin's lamp" for unravelling the miracles of life.

Research Notes

Glorious Capital of the Andhras

In a paper read before the Twentieth International Congress of Orientalists held at Brussels in September, 1938, and later published in the *Indian Arts and Letters* (Vol. XII, No. 2, p. 83-89) Mr Syed Yusuf, the Asst. Director of Archaeology in the Hyderabad State, gave an important account of the excavation recently carried out at Paithan, the site where lies the buried city of 'Patitthana' of the old Pali literature, and the 'Glorious capital of the Andhras' described by Pliny, Ptolemy etc.

Dravidian in its early origin the ancient city was one of the great centres which played a prominent part in the cultural life of the East. As the exact site of the city was not known, four favourable sites were selected on the northern bank of the Godaveri and excavations were started in 1937. Two sites gave satisfactory results and in one were noticed six consecutive layers of previous habitations. The antiquities unearthed tallied completely with the cultural characteristics of each relative stratum. The topmost layer exposed finds of only recent origin. The next stratum yielded coins of Asaf Jahi Dynasty (18th Century); the third gave silver and copper coins of the Mughal period. The fourth and fifth strata were jumbled up and showed clear marks of some sort of catastrophic devastation, which, as the finds of Tughlak and Bahmani coin in these layers indicate, took place sometime towards the close of the fourteenth century. The sixth layer which is of much greater antiquity exposed structures built of burnt bricks and mud mortar showing that they were constructed long before the use of lime came into vogue. The smaller antiquities found in this stratum practically covered every department of life. Terra cotta beads, the earliest specimens of primitive jewellery, were found in large numbers and variety of shapes. The terracotta figurines found were crude and decidedly primitive, the workship showing striking resemblance to that of figures found at Mahenjo Daro, Chanhu Daro and other pre historic sites. Bangles, finger rings, beads and other decorative objects of shell, coral and mother-of-pearl and ivory objects, all showing a high standard of workmanship, have also been found. A large variety of stone beads were also unearthed which shows cultural affinity of the Deccan with the civilizations of the Indus Valley and recall the statements of the ancient Greek, Roman and Egyptian writers who paid a high tribute to the bead industry of Paithan. The copper coins recovered show only slight variations from Andhra coins found at Taxila.

S. D.

Atmospheric Electric Conductivity at Bombay

In fair weather, the earth's surface has a charge of negative electricity, and near the ground, the electric potential increases with height at the rate of about 100 volts per metre. The presence in air of electrified particles or 'ions' causes a small conductivity and motion of the ions due to the potential gradient causes an 'air-earth current.' These quantities are never steady but change with meteorological conditions depending mainly on the presence of haze or fog in the atmosphere.

Of the few systematic observations of these quantities made in India, the earliest observations were those taken at Simla by Simpson in 1910. In 1930 atmospheric electric observations for measurements of potential gradient were started at the Colaba Observatory, Bombay. Two types of variation

of the potential gradient, one characteristic of the south-west monsoon and the other of the dry months, were recorded. The observations of, potential gradient have now been supplemented by those of atmospheric electric conductivity. (*Scientific Note of the Indian Meteorological department*, Vol. VII, No. 79, by Mr S. M. Mukherji). From the potential gradient and the conductivity it is possible to calculate in a simple manner the small electric current that flows from the atmosphere to the earth or *vice versa*. The mean monthly potential gradient has been found by Mr. Mukherji to be maximum in mid-winter and minimum in May. The conductivity varies roughly inversely to the potential gradient. The small conductivity in winter is ascribed to the stability of the atmosphere and the character of the air movement over Bombay. In that season the air near the ground collects a considerable quantity of smoke and the nuclei from the city during certain parts of the day; the number and the mobility of the electrified particles in the atmosphere are thereby reduced.

Between May and September, however, owing to the strength and gustiness of the wind and the air blowing in from the sea, the conductivity shows high values. Other interesting conclusions from the experiments are the increase of air-earth current with the onset of the monsoon, the higher conductivity during the night with the exception of winter and the minima of these at sunrise and sunset. The daily variation of potential gradient over the ocean is very simple in character and depends not on local time but on universal time. Since air over Colaba during the monsoon comes directly from the sea, the diurnal variation in the season is a near approach to that over ocean. Even in winter, however, the trend of variation is similar but the disturbance produced by local effects is much too large for the similarity to be conspicuous.

The average value of the potential gradient at Bombay was 150 volts/metre and conductivity 2.5×10^{-4} electrostatic units and of air-earth current 5.9×10^{-7} electrostatic units or 2.0×10^{-16} amperes per square centimetre of the earth's surface.

Integration of X-ray Crystal Reflections

In recent years the methods of measurement of integrated intensities from single crystal X-ray diffraction photographs have practically replaced the extremely time-consuming methods of the ionization chamber. But as the deflection of the photometer in measuring the blackening of a diffraction spot cannot be taken to be proportional to the original X-ray intensity, that produced the blackening, it is necessary to scan the whole diffraction spot by making the scanning light of the photometer so fine as to cover a practically uniform area of the spot. The photoelectric current is then matched continuously against a standard. Thus the time required to study each diffraction spot is considerable though less than that for the ionisation chamber. It has been found by R. H. V. M. Dawton (*Proc. Phys. Soc.* *50*, 919, 1938), that when a print of an X-ray diffraction photograph is taken on a film, the photometric deflection for this film bears a linear relation to the intensity of irradiation on the original X-ray photograph, under suitable conditions of developing and printing. So the beam of the scanning light may be made sufficiently large as to cover the whole diffraction spot and the integrated intensity obtained directly from the photometer deflection. It is claimed that "this enables the measurement of the film to be completed in about one tenth of the time required by existing methods and without the use of complicated apparatus such as alpha-ray photometer or the mechanical integrator at present necessary." If this method proves as successful as is claimed by its author, one can easily understand the amount of saving in labour: it will mean to crystallographic workers when one considers the large number of integrated intensities that are necessary for studying a crystal of even moderate complexity.

K. B.

Odd Co-ordination Complexes

It is of considerable interest to know, following the classical conceptions of co-ordination of Werner, whether odd co-ordination complexes with co-ordination number, say 7, can exist, and if so, what may be the possible orientation of the seven co-ordinating atoms, ions or group in space surround- the central atom. The rotation analysis of crystals of ammonium fluozirconate and hafniate was first made by Hassel and Mark (*Z. Physik*, *89*, 27, 1924), with this point in view. Quite recently, Hampson and Pauling have carried out a similar study of the

structure of ammonium and potassium fluozirconate crystals (*J. A. C. S.*, *11*, 2702, 1938). They have used the data obtained from Laue, oscillation and powder photographs to derive the conclusion that the substances do not contain separate F' and $[ZrF_6]''$ ions as indicated by the previous workers, but contain instead the complex ion $[ZrF_7]'''$. The structure of the crystals is similar to that of $(NH_4)_3AlF_6$ with the $[AlF_6]'''$ group replaced by $[ZrF_7]'''$. The configuration of the complex anion has been deduced on the strength of these data to be a distorted $[ZrF_6]''$ octahedron, the seventh fluorine ion occupying a face of the octahedron, at a distance of 1.9A, which is nearly the same as the Zr-F distance for the other fluorine atoms (2.1 A). The authors point out that the existence of a complex like $[ZrF_7]'''$ is to be expected. The minimum radius ratio required for the formation of seven cornered polyhedron (as ZrF_7''') is 0.592; the experimental value of the ratio of radii of zirconium and fluorine in $[ZrF_7]'''$, obtained from tables of ionic radii, is 0.80, which therefore corresponds to stability of co-ordination number 7 and even higher. A similar co-ordination polyhedron having seven corners is found in some modifications of lanthanum and other rare earth sesquioxides, in which each rare earth ion is surrounded by seven oxygen ions (Pauling, *Z.Krist*, *69*, 415, 1929

J. G.

Assay of Vitamin B_1

Recently much attention has been given to the estimation of vitamin B_1 for it has been well recognised that a chemical method would greatly facilitate many of the investigations with the vitamin. The process involving colorimetric estimation of 'Thiochrome', to which the vitamin B_1 can be quantitatively converted has found wide application (*Rec. Trav. Chim.*, *55*, 1046, 1938). The scope of the method depending on the growth promoting effect of vitamin B_1 on a mould, *Phycomyces Blakesleeanus*, has, however, been found to be limited (*Bull. Soc. Chem. Biol.*, *17*, 1097, 1935). The fermentation method depending on the measurement of the accelerating power towards the fermentation of glucose by Fleischmann yeast has been suitably used for detecting 10 γg. of the natural or synthetic vitamin (*J. Amer. Chem. Soc.*, *59*, 948, 1937). An extension of the Thiochrome method has been made by Jansen (*Chem. Weekblad*, *35*, 565, 1938) to determine aneurine content in foods. The blue colour is best measured by the fluorescence, which is measured on a photoelectric cell against a quinine sulphate standard. A satisfactory method for the determination of aneurine pyro-phosphate has also been indicated (*Loc. Cit*). The interesting method of Otto and Rühmakorb (*Dtsch. Med. Wschr.*, *64*, 1511, 1938) entails a comparison of fluorescence of the isobutyl alcohol extract from a mixture of $K_3Fe(CN)_6$ and the vitaminous fluid with a standard solution of pure vitamin prepared likewise. In his colorimetric method Tauber (*Mikrochim Acta*, *3*, 108, 1938), has treated the vitamin preparation with 1% $K_3Fe(CN)_6$ followed by a solution of caustic soda and potassium cyanide. The mixture on shaking with sulphuric acid has been treated with a solution of F''' gumghatti solution and the colour development has been compared with standards.

S. K. M.

UNIVERSITY AND ACADEMY NEWS

PROCEEDINGS AND PUBLICATIONS

Indian Chemical Society

(*Calcutta, November, 1938 J.I.C.S. 15, 573 615, 1938*)

S. S. BHATNAGAR, P. L. KAPUR AND MAHBUB SHAH HASHMI: Phototropy and photochemical isomerism from the magnetic standpoint.

N. R. DHAR AND S. K. MUKERJEE: Denitrification in sunlight and its retardation. Part IV.

W. V. SUNDARA RAO, P. V. KRISHNAMURTI AND G. GOPALA RAO: Mechanism of the microbiological oxidation of ammonia. Part I. Formation of intermediate products.

JAMIAT V. LAKHANI AND RUSTOM P. DAROGA: The determination of the parachors of inorganic salts in solutions. Part III. The Prarachors of some salts of magnesium, strontium and barium, and the atomic parachor of the above elements and radium.

R. CHATTERJEE: Oxalenediamidoxime. Part I. estimation of nickel..

S. C. GANGULY: On the estimation of fumaric and maleic Acids.

BALWANT SINGH: Note on oxidation of ferrous iron with potassium iodite.

Botanical Society of Bengal

(*Calcutta, 21st January, 1939*)

BASUDEV ROY: Pollination studies in Prunus.

ANNOUNCEMENTS

National Institute of Sciences of India

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Prof. F. E. Fritsch, F.R.S., and Prof. A. H. R. Buller, F.R.S., were unanimously elected as Honorary Members of the Society.

RESEARCH WORK IN INDIA

(*Bose Institute, Calcutta, 1938*)

The work carried out, at present, in the Bose Institute are along the lines laid down by Sir J. C. Bose, namely, the study of the phenomena of life by means of the uptodate method of physico-chemical investigations and the applications of the results to the sciences of agriculture and medicine.

The study of plant physiology along the classical lines, initiated by Sir Jagadish is being continued with the apparatus made in the Institute workshop together with the help of newer methods, which recent developments in physics and chemistry have placed in the hands of the plant physiologist. A new line of work has been introduced, the study of the effect of plant hormones on the growth and tropic movement of plants. Investigations have been initiated on the effect of vernalization and photo-periodism on the growth of plants. The study of plant genetics is also being taken up. Semi-field methods of investigations of agricultural problems are carried out in the experimental station at Falta. Here during the last few years systematic investigation of the dietetic value and vitamin contents of different food stuffs have been carried out. Further, preliminary work on the microbiology of the different types of soil at Falta has begun this year.

In the chemistry department work on analysis of soil, of food stuffs, investigations of the chemical constitution of the principal constituents of Indian medicinal plants are being proceeded with.

In the department of zoology systematic observations on the habits of different species of spiders and ants have been carried out. Some preliminary studies of the life history and habits of some of the common fishes of Bengal have been made.

During the last few years, a small department of anthropology, been maintained where recently the study of blood groups in the indigenous population has been taken up.

The physics laboratory is equipped for investigations in spectroscopy, ultra sonics, natural and artificial radioactivity and cosmic radiation. The investigations in radoactivity is being undertaken both for the intrinsic interest of the subject and also for the production of radio-active istopes of elements, which are finding important applications as indicators in biological reactions. At present neutrons are being produced in the laboratory by the action of radiations of radium on beryllium. Other methods of producing intense neutron sources are under investigation.

The high altitude Bacharaj Laboratory in *Mayapuri*, Darjeeling, is favourably situated for the investigation of cosmic radiation. Recently, impregnated photographic plates, kept in the Dak Bungalow at Sandakphu (elevation 11,500 ft.) for a period of five months, revealed, after development, many star-like tracks of nuclear disintegration products produced by cosmic rays, in conformity with the results obtained by observers in other high altitude laboratories.

In addition to these investigations, a very lively Colloquium on nuclear physics is being conducted in co-operation with the departments of physics and applied mathematics of the University College of Science, Calcutta.

BOOK REVIEW

THE PROGRESS OF SCIENCE IN INDIA DURING THE PAST TWENTY FIVE YEARS. *Edited by Dr B. Prashad, D.Sc., F.R.S.E., F.R.A.S.B., F.N.I., Director, Zoological Survey of India, Indian Museum, Calcutta. Published by the Indian Science Congress Association, 1, Park Street, Calcutta, 1938, pp. LVI + 767, Price Rs. 5.*

It was really a happy idea to bring out on the occasion of the Silver Jubilee of the Indian Science Congress Association, a number of volumes dealing with the progress of all sciences, both pure and applied, in India, during the last quarter-century. The first of the series, a treatise on Field Sciences in India has been previously reviewed in the columns of this journal. The present volume is the second of the series and is intended to give a general review of the progress of scientific research in India during the last twenty-five years. The thanks of the whole of scientific India are due to the executive committee of the Indian Science Congress Association for the conception and to Dr B. Prashad for the execution of the work. Dr Prashad is to be specially congratulated upon for the thoroughness and the meticulous care with which he has accomplished the task entrusted to him.

A look into the contents of the volume reveals that it covers almost all the branches of basic and applied sciences. The volume is divided into eighteen sections and all these sections have been written by competent and well-known authorities. The sections have been arranged as follows:

I. Introduction—By B. Prashad.
II. Progress of Scientific Education in India During the Past Twenty five Years—By W. A. Jenkins.
III. „ „ Mathematical Research—By B. M. Sen.
IV. „ „ Chemical Research—By J. C. Ghosh.
V. „ „ Geology and Geography—By D. N. Wadia.
VI. „ „ Agricultural Science By W. Burns.
VII. „ „ Veterinary Research By F. Ware.
VIII. „ „ Dairy Husbandry By Z. R. Kothavalla.
IX. „ „ Archaeology—By K. N. Dikshit.
X. „ „ Anthropology By B. S. Guha.
XI. „ „ Psychology G. Bose.
XII. „ „ Zoology By H. S. Rao.
XIII. „ „ Forestry By H. G. Champion.
XIV. „ „ Engineering By W. C. Ash.
XV. „ „ Physiology—By S. S. Bhatia.
XVI. „ „ Medical Research By U. N. Brahmachari.
XVII. „ „ Physics By M. N. Saha.
XVIII. „ „ Botany By S. P. Agharkar.

In his well written introduction, Dr Prashad traces the development of scientific research in the country from about the beginning of the last century to the first decade of the twentieth century and describes the parts played by learned societies, like the Asiatic Society of Bengal, the various services and the Survey departments of the Government and the different universities and research institutes.

The article on the Progress of Scientific Education by Dr Jenkins presents a retrospect and clearly sets forth the future problems, suggesting the way of their solution. Though there may be difference of opinion regarding this or that point raised by Dr Jenkins, there would be general agreement over his main thesis that scientific education imparted in the schools in the different provinces of India is far from satisfactory and with such unsatisfactory foundation it is hardly possible for the universities to achieve reasonably good results. He will also have the support of all scientists and educationists, when he puts forward a strong plea for the reorganisation of secondary school systems so as to impart sound preliminary scientific training, for the co-operation of industrial

and commercial firms in connection with research activities and for securing endowments for research in the pure sciences, which have no immediate direct commercial applications.

In the chapters that follow, attempts have been made to set forth the developments in various sciences by workers in the universities, in scientific institutes, scientific departments of the Government and other cognate agencies all over the country. In general, the mode of presentation is historical, short accounts of work carried out during the period in each of the different branches of science being presented in a narrative and chronological form. The lack of uniformity in one respect is rather conspicuous. In a volume like this, which is sure to be used largely as a book of reference it would have been much better if some uniform method of citation of literature were adopted.

The volume, which is a compendium of the contributions of Indian workers in the field of positive sciences in the brief period of the past twenty-five years, shows how much has been done and how rapid the progress has been. One thing stands out prominently: in spite of the fact that research work encounters many difficulties in this land, which are absent in others and considering the unsatisfactory nature of preliminary scientific education and utter inadequacy of financial resources of the different educational institutions, the volume of research work which is now being done in the country is remarkable.

The volume, in our opinion, is a monumental work and will form an indispensable book of reference for all subsequent times.

S. D.

THEY WROTE ON CLAY: The Babylonian Tablets Speak Today—*by the late Edward Chiera, Late Professor of Assyriology, the University of Chicago and edited by George C. Cameron, Instructor in Oriental Languages, the University of Chicago. (The University of Chicago Press, Chicago, Illinois, U.S.A., 1938)*; pp. XV+235. *Price 3 dollars.*

This is a brilliantly written account of the civilization of Babylon and Assyria as revealed by excavation and the study of the cuneiform tablets in clay and stone, intended principally for the general reader who is not in any way a specialist in the subject. It is an achievement of the modern age to bring the results of higher science and scholarship to the average individual who has the requisite curiosity but not the adequate intellectual training in a manner which stimulates that curiosity and attracts him to the "romance" of the subject, frequently helping him to acquire more detailed knowledge by further painstaking study. In this art of vulgarisation French scholarship is said to excel; and certainly in the English-speaking world. America has earned a just reputation in this direction. A not fully erudite populariser who is not a finished expert, frequently does more harm to his subject than good by committing errors of commission and omission and wrong emphasis which puts it in a false light. The ideal is achieved when the expert becomes a successful vulgarisator, when he can lighten his own burden of scholarship while passing it on to the average intelligent man, leaving it with a reference only to the essentials and lighting it up with wit, with imagination and with philosophy.

The present work is a very attractive treatment of a subject which has a wide interest, concerned as it is with some of the bases of modern civilization. Prof. Chiera, practical excavator as well as scholar that he was, takes us in this book, posthumously published, through the story of excavations for treasure hunting to the clay documents and the city mounds, tells us about the nature of Sumerian and Assyrio-Babylonian writing, and discusses the nature of the materials laid bare by the cuneiform texts, literature and business documents and political or official papers and private letters and such like. The resurrection of the life and culture of ancient Babylon is unfolded before our eyes in as non-technical a manner as can be expected from the scholar who was an authority in his subject. Ancient Babylonian life, as in the documents of cuneiform texts and in the art associated with them is always compared with modern conditions in Mesopotamia and Assyria. The implications of Babylonian civilization for the Modern World are not forgotten, and how Babylon worked through Palestine, Greece and Rome up to the modern world is told convincingly. The connections of Babylonian

culture with that of Mohen-jo-Daro and Harappa in India are not passed over in silence.

The book is illustrated by a number of very fine pictures—we only wish the reproduction was slightly better in some cases—and some of these give reconstructions of scenes and situations in old Babylonian life. It is a fine book to give to our boys, and to our college students even when making a special study of the history of the Near East. We hope the work will have the wide publicity which it richly deserves.

S. K. C.

DAS MIKROSKOP—*by A. Ehringhaus; (B. G. Teubner, Berlin & Leipzig) pp. 156.*

Dr Ehringhaus belongs to the research department of the firm R. Winkel of Gottingen, the famous microscope makers. This interesting small book deals, within a short compass, the theory and application of modern microscopes. The first two sections deal with the optics of the microscope, in which one finds the question of magnification and field of view clearly discussed. The third section relates to the various factors composing a modern microscope in which treatment of illuminated and self luminous objects are clearly brought out and the resolving power for different classes of objectives have been drawn in a table. The fourth section concerns with the measurements of microscopic preparations. The fifth and the sixth sections form a very interesting portion of the book in which the determination of optical constants of microscope parts and the testing of performances of microscopes has been very clearly developed. In the seventh section one finds the various accessories needed for microscope practice and the eighth deals with the binocular microscopes. The ninth section is devoted to dark-ground illumination and the eleventh relates to ultra-microscopy and improved methods in dark-ground illumination. The tenth deals with ultra-violet and flourescence microscopy. In the twelvth, thirteenth and fourteenth sections one finds the microscopic technique, as used in various investigations clearly indicated within a short compass. The last chapter introduces the modern electron microscope and shows how the field of application of microscopy has been extended beyond expectations.

Though it is a book from a specialist, the treatment is sufficiently elementary and for people who have constantly to use the microscope for precision work, the various aspects of the technical microscopy would be not only interesting, but useful.

P. N. G.

INTERMEDIATE PHYSICS Part I (Mechanics)—*by Mr D. S. Jog, M.Sc., Asst. Professor of Physics, Fergusson College, Poona. (Karnatak Publishing House, Bombay 2) pp. X + 334.*

In the opinion of the author there is practically no text book of physics that covers the latest syllabi of the I. Sc. standard of Indian universities, and to remove this want he has undertaken the publication of this text book of Intermediate Physics.

The author has endeavoured to elucidate all points of fundamental physical importance and has described familiar applications of physical principles with a view to create an interest for the subject in the mind of the young learners. That is a good idea. But to achieve this he has paid no attention to conciseness and has made the volume rather too bulky. This has also been necessary as the author's aim has been, to quote his own words, " to present the material in such a manner that students may themselves, without help from teachers, acquire the necessary mastery of the subject."

According to the reviewer, the necessary matter contained in this book could have been condensed to a much smaller volume without the least sacrifice of clarity. Many writers of junior text books in this country seem to work under the delusion that conciseness and clarity are mutually exclusive and there is also the tendency to usurp the function of the teacher altogether. No text book, however perfect and lucid the treatment may be, can do away with the necessity of a teacher, and unnecessarily increasing the bulk with that end in view is always a wrong idea.

The printing and get up of the book is good.

S. D.

Letters to the Editor

[The Editor is not responsible for the views expressed in the Letters.]

The K-absorption edges of cobalt in cobalt metal and in its compounds

The primary and secondary K-absorption edges of metallic Cobalt in the hexagonal crystalline form have been investigated by Lindsay and Kievit[1] and also by Sawada[2]. Kronig[3] has put forward an explanation of the origin of these secondary edges. Though Kronig's theory generally holds good for metals and non polar compounds, it fails in the case of polar compounds[4]. The reason for this failure has not yet been fully understood. The present investigation was undertaken with a view to study the difference in the structures of the secondary K absorption edges of Cobalt in Cobalt metal and in ionic Cobalt compounds.

A Seigbahn spectrograph was set up and the X ray tube was run at 10 KV, with a current of 20 mA. The thickness of the absorption screen was varied from 5 to 10 m.g. per square centimetre and photographs were taken with a calcite crystal rotating through 2° 30′ min. The time of exposure varied from 50 to 60 hours. As is well known, proper thickness of the absorption screen plays a very important part in these experiments and also it is extremely difficult to obtain a good plate in which the contrast between the white and dark lines comes out prominently. Again another interesting feature in these experiments lies in the fact that in some compounds secondary edges come out easily while in others they are obtained with great difficulty. As an example, we may cite the case of CoO, for which we have tried, in vain, 15 exposures to obtain a good plate, whereas in the case of Co_2O_3 the edges are quite prominent. The powder diagram shows clearly that CoO is not amorphous but crystalline in structure.

TABLE I

The wavelengths are given in X.u.

Substance	K	α	K_1	β	K_2	γ	K_3	δ	ϵ	η	z
Co Cobalt metal	1605 x.u.	1595 x.u. D	1589 x.u.	1582 x.u.	1580 x.u.	1578 x.u.	1570 x.u.	1563 x.u. D	1556 x.u.	1523 x.u.	1510 x.u.
CoO Cobaltous oxide	1603	1595	1591	1581 D	..	1570 D	..	..	..	..	1510 D
Co_2O_3 Cobaltic oxide	1604	1595 D	1587	1584 D	1580	1577 D	..	1561 D	..	..	1506
$Cocl_2, 6H_2O$ Cobaltous chloride	1601	1595 (D?)	1588	1583	1576	1571	..	1562 D	..	1515	..
$CoSo_4, 7H_2O$ Cobaltous sulphate	1602	1595	1591	1582 D	1570	1565 D	..	1551 D	..	1512 D	..
$Co(No_3)_2, 6H_2O$ Cobaltous nitrate	1602	1596	1592	1582 D	..	1563 D	..	1557 D	..	1526	1508
Cobalt[2] nitrite	1602	1595	1591	1583	..	1559	..	1556	..	..	..

[1] Always associated with Co_3O_4.
[2] Cannot be obtained in the pure form, contains Cobaltic and Cobaltous nitrite and also Cobaltous nitrate.
D. denotes the double character of the bands which has not been separted.

LETTERS TO THE EDITOR

Table I gives the results of our preliminary measurements which are made with a glass scale and as the secondaries are very faint, an error of 1 to 2 x.u. is quite possible. In this table the main primary edge is denoted by K, whereas K_1, K_2, K_3 and α, β, γ etc. denote the centres of the white and black secondary bands respectively. The exact position of any sharp *edge* in the secondary absorption spectra for both the white and black bands is impossible to locate.

The following peculiarities are noted:

(*a*) The intensities and breadths of the white and black bands do not follow any regular sequence.

(*b*) The primary K edge of Co in the pure metal has a longer wavelength than those in the oxides. In the case of chloride, sulphate, nitrate and nitrite, the position of the primary K edge is nearly the same, but less than that of the oxides.

(*c*) Cobalt nitrate gives a white band (1623 x. u) on the long wavelength side of the primary K edge about whose reality nothing can be said at the present moment.

(*d*) The secondary edges do not extend equally in the case of all the cobalt compounds. As for example, in the case of cobalt nitrate the farthest secondary lies at a separation of 480 volts from the primary edge whereas in the case of cobalt nitrite this difference is only 230 volts.

(*e*) The breadths of the white and black bands are not identical in the metal and its salts.

(*f*) It appears that the black bands of cobalt metal and its compounds, marked *D* in the table are not uniform in intensity and it is quite likely that a faint white line is present in the above band.

(*g*) The crystal types of the salts are different in the substances examined.

(*h*) A black line (1510 x.u.) is observed in the case of cobalt (metal), which has not been observed before.

Cu, K, α_1 α_2 and WLl were taken as reference line in all these measurements. More accurate measurements with the micro-photometer records will be published later on.

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3-2-39

[1] Lindsay and Kievit—*Phys. Rev. 36*, p. 648, 1930.

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A Note on Graduation by the Method of Least Squares

Various methods of smoothing data are employed by actuaries but statisticians are more familiar with only one important method namely that based on the Method of Least Squares.

The general problem where curve fitting is called into play by the statistician is when he has $n_1, n_2, \ldots, n_i, \ldots, n_k$ observations of a dependent variable y corresponding to the values $x_1, x_2, \ldots, x_i, \ldots, x_k$ respectively of an independent variable x. He wants to establish a functional relationship between a given value of x and the mean value of y for that value of x. He calculates the means $y_1, y_2, \ldots, y_i, \ldots, y_k$ of the $n_1, n_2, \ldots, n_i, \ldots, n_k$ observations of y and postulates that the n_i observations of y at $x=x_i$ are individuals drawn at random from an infinite Normal population with mean m_i and standard deviation σ_i.

If m_i and σ are known quantities the probability distribution of $y_1, y_2, \ldots, y_i, \ldots, y_k$ is

$$\text{Const. } c^{-\frac{1}{2}\sum_{i=1}^{k} \frac{n_i (y_i - m_i)^2}{\sigma_i^2}} \prod_{i=1}^{k} dy_i \qquad (1)$$

Usually the σ's are not known and it is assumed that $\sigma_1 = \sigma_2 = \ldots = \sigma_k$. In addition it is postulated that the m's are linked together by a set of parameters $a, b, c, \ldots$ such that

$$m_i = a + bx_i + cx_i^2 + \ldots \qquad \ldots \qquad \ldots \quad (2)$$

The object of curve-fitting is to get the best estimates of the unknown parameters $a, b, c, \ldots$. The *likelihood* of $a, b, c, \ldots$ is, from definition,

$$L = \text{Const. } c^{-\frac{1}{2\sigma^2}\sum_{i=1}^{k} n_i (y_i - a - bx_i - cx_i^2 - \ldots)^2} \quad \ldots \quad (3)$$

By maximising L which comes to the same thing as minimising

$$\sum_{i=1}^{k} n_i (y^i - a - bx_i - cx_i^2 - \ldots)^2 \qquad \ldots \quad (4)$$

we get the best estimates of $a, b, c, \ldots$. The process of minimising (4) is popularly known as the 'Method of Least Squares.'

Now it may well happen that y instead of being a continuous variable is taking only either of the two arbitrarily fixed values 1 and 0 according to the presence or absence respectively of a particular attribute. Thus $x_1, x_2, \ldots, x_k$ may be the ages of males and the attribute studied may be 'marital state.' In that case y_i becomes the proportion who are married out of n_i males observed of age x_i. The whole of vital statistics and demography abound in problems of similar nature.

The peculiarity of y in this case is that it does not follow Normal law. On the other hand it is known to conform to

the Binomial law. $\bar{y}_i$ becomes a probability value p_i based on n_i observations and σ^2/n_i, the variance of y_i, is replaced by $p_i q_i/n_i$ the variance of p_i. It is clear therefore that the method of Least Squares is not applicable and that the further assumption of $\sigma_1 = \sigma_2 = \ldots \sigma_k$ is definitely erroneous.

A way out of this difficulty can be suggested as the result of a recent work of M. S. Bartlett[1] who was faced with the problem of analysis of variance of agricultural field trials where the character studied may be proportion of diseased plants or proportion of germinated seeds, etc., which do not follow the Normal law. He suggested that the transformation

$$\theta = \sin^{-1}\sqrt{p} \quad \ldots \quad \ldots \quad (5)$$

will make θ more nearly Normal than p and also stabilise the variance of θ [say, $V(\theta)$] on account of the approximate relation

$$\frac{V(\theta)}{V(p)} = \left(\frac{d\theta}{dp}\right)^2 = \frac{1}{4p(1-p)} \quad \ldots \quad \ldots \quad (6)$$

and as $V(p) = p(1-p)/n$, $V(\theta)$ becomes proportional to $1/n$. If p is very small the square-root transformation will be found sufficient.

We can now make use of this transformation in our problem of curve fitting where the dependent variable is a probability estimate. Special Tables for calculating θ corresponding to a given p have been supplied by Fisher and Yates.[2] Since $V(\theta)$ is proportional to $1/n_i$ we have only to minimise

$$\sum_{i=1}^{k} n(\theta_i - a - bx_i - cx_i^2 - \ldots)^2$$

and the final relationship between p and x will be obtained as

$$p = \sin^2(a + bx + cx^2 + \ldots)$$

It is hoped that actuaries and statisticians will find this method one of wide application to data such as specific mortality rates, specific fertility rates etc., at different ages.

Statistical Laboratory,
Calcutta, 12-1-39. K. Raghavan Nair.

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Some observations on the sex-stimulating hormone extracted from the human urine of pregnancy

The presence of a hormone in the urine of pregnancy which rapidly matures the ovaries of infantile mouse was first noticed by Zondek and Aschheim.[1] Since then methods have been developed by Van Dyke,[2] F. Dickens,[3] Fischer,[4] Haurowitz,[5] Funk,[6] Katzman and Doisy[7] and others to obtain this hormone from urine in a concentrated form. In our experiments, we separated the active material from urine by adsorption on benzoic acid and then removed the benzoic acid by treatment with acetone as suggested by Funk (*loc. cit*) and Katzman and Doisy (*loc. cit*).

The stability of this hormone at different pH was tested. F. Bischoff and L. Long[8] recorded that at 20°C, 80% of the activity is destroyed in 24 hours by dil. HCl solution. We found that the substance is fairly stable between the range of pH 3.6 to 8.6. From Table I it will appear that at pH 3.6 it has got the maximum stability as measured by the increase in weight of ovaries and uterus of immature albino rats. The weight of the rats varied from 30 gm. to 40 gm.

TABLE I

pH	The mean weight in mg. of the uterus and ovaries per gm. of the mean body weight.
8.6	2.8
5.6	2.5
3.6	3.4
Control ..	1.9

In the course of these experiments it was noticed that at pH 3.6 a precipitate is formed which is inactive while the whole of the activity is preserved in the supernatant solution. This suggested a method of further purification of the active material from the associated impurities. A solution containing 20 mg. of the crude extract per c.c. was adjusted at pH 3.6 by glacial acetic acid and the precipitate formed was removed by centrifuging. The clear supernatant solution was treated with 10 times its volume of acetone previously cooled to about 10°C. The precipitate formed, contained practically all the activity of the original substance and was separated by centrifuging. It was then dried to constant weight over $CaCl_2$ in a vacuum desiccator. A white amorphous highly hygroscopic powder which is about 41.11% of the original crude extract was obtained. This purified substance was analysed. The crude extract from urine obtained by benzoic acid precipitation contained 12.08% nitrogen. The purified material separated from the supernatant solution at pH 3.6 contained 6.89% nitrogen. Its carbohydrate content as determined by orcinol sulphuric acid method of Sörensen and Haugaard,[9] as improved by Kondo and Murgama,[10] was 6.68% and Tyrosin content as determined by Wu's[11] method was 2.2%. It may be mentioned that the carbohydrate content of the purified material obtained by us was considerably less than the value 19% found by Max Hartzman and Firtz Benz.[12]

Further work in this line is in progress. I wish to thank Dr B. N. Ghosh, for his advice and guidance and to Dr J. C.

LETTERS TO THE EDITOR

Ray, M.D., Director, Indian Institute for Medical Research for the facilities afforded to carry out this work.

Apurba Chandra Majumdar.

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Calcutta, 25-1-39.

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Polarity of Hormone Transport in the Coleoptile of Triticum

It has been concluded by a number of investigators that the movement of growth substance in the living tissues of plant is a polar phenomenon and it occurs only in a basipetal and not in an acropetal direction. There are, however, some investigators who have expressed doubts regarding strict polarity of hormone transport in plant. Hitchcock[1] and Zimmerman, and Snow[2] observed acropetal movements of auxin when applied in concentrated form. But these observations being recorded in presence of high concentration of auxin were not considered to be sufficient reasons for doubting the polarity of the normal auxin transport in the plant. Both Cholodny[3] and Pohl[4], claim that auxin moves from the seed upwards into the coleoptile. But Skoog[5] concluded that the substance transported from the seed as observed by Cholodny and Pohl is auxin precursor and not true auxin, which is converted into auxin in the coleoptile tip. Skoog, however, did not deny that it is convertible into true auxin in the seed itself.

In our present investigation it has been found that growth substance can be transported both in acropetal and basipetal directions in the coleoptile of Triticum. The movement of growth substance was detected from observation of geotropic curvature of the coleoptile stump. The seedlings were grown in a dark and moist chamber, the temperature of which varied from 26° to 32°C, during the time of experiments. Seedlings of 68 hours growth from the time of sowing and having a length of 30 to 45 mm. were used in the experiments. The seedlings were deseeded and for total removal of the residual growth substance they were decapitated in two cuts at an interval of two hours. The total length removed from the tip was 10 mm. The primary leaf was removed and only the hollow coleoptile stump was used in the experiments. In such a stump, when kept horizontal, no geotropic curvature was found to occur. But when a coleoptile tip was attached to either of the cut ends a definite geotropic curvature was found to appear at the apical region within four hours; the experiments were, however, continued for twenty hours for obtaining the maximum geotropic curvature. The coleoptile stumps under such condition were loosely clamped at the middle and were wrapped up with moist cotton strips in the mid region.

Three series of experiments were performed side by side: (1) by attaching the tip to the apical end, (2) by attaching tip to the basal end, (3) control experiments without any tip attached. Two measurements of curvature were recorded, one at the end of four hours and the other after twenty hours. Photographs were also taken after twenty hours. The results of the experiments are summarised below:—

Tip attached at the apical end.			Tip attached at the basal end.			Control experiments without tip.		
No. of specimens.	Average curvature in degrees within 4 hrs.	Average curvature in degrees within 20 hrs.	No. of specimens.	Average curvature in degrees within 4 hrs.	Average curvature in degrees within 20 hrs.	No. of specimens.	Average curvature in degrees within 4 hrs.	Average curvature in degrees within 20 hrs.
62	19	58	57	13.5	48	57	0	4.8

LETTERS TO THE EDITOR

The photographs of three different series of experiments are given in figures (a), (b), and (c).

Fig. (a).
Tip attached at the apical end.

Fig. (b).
Tip attached at the basal end.

It will be evident from the above table and the photographs that the tip, attached either at the base or at the apical end, can induce geotropic curvature in a coleoptile stump which is otherwise insensitive to the stimulus of gravity, and that whether the tip is attached to the apical or the basal end geotropic curvature occurs only in the apical

Fig. (c).
Control experiment without any tip attached.

region. The source of auxin being the coleoptile tip itself, the question of its unphysiologically high concentration does not arise; the substance transported cannot be auxin precursor on the same ground.

Bose Research Institute, Calcutta, 11-2-39.

B. Dutta.
A. Guha Thakurta.

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ERRATA

In February issue (Vol. IV, No. 8) *read*

on p. 447, para. 3, lines 3-4, 100°K and 373°K *for* 100°A and 373°A

on page 452, para. 1, line 18, $\mu_p = 2.9\ \mu_0$, *for* $\mu_p - 29\ \mu_0$.

on page 474, the three formulae shall be as shown below, arranged in order.

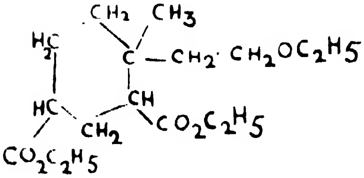

Fig. I

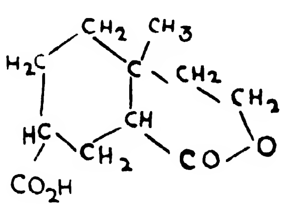

Fig. II

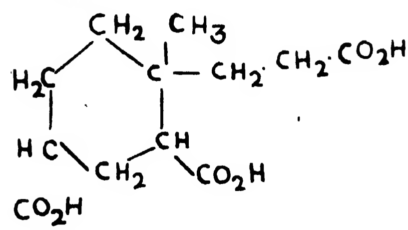

Fig. III

SCIENCE AND CULTURE

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VOL. IV NO. 10

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From "Vegetable" to "Mineral" Civilization

It was only the other day that the well-known British writer, Mr H. G. Wells, while at Bombay on his way to Australia, gave an interview to a Press representative and characterized the system under which the Indian population lives as a "Vegetable Civilisation". The full implication of this statement, we are afraid, has not been fully grasped. Probably Mr Wells meant our dependance to a very large extent on agriculture *i.e.*, on the plant world for food, clothing, housing, and other necessities and luxuries. The Indian leaders also, by mainly emphasizing on agriculture, on rural life and on village crafts, have shown themselves incapable of understanding the way in which the world progresses. One like Mr Wells, who surveyed the history of the world from the point of view of progress of human civilization, such views of the Indian leaders are sure to strike not only as unprogressive but suicidal in the long run. If India is to grow into a powerful world-entity like the U.S.A., Soviet Russia, and the countries of Western Europe, this growth can not be fostered by continuously harping on the supposed virtues of "Vegetable" civilisation. A nation, however great its moral and spiritual qualities may be, can not hope to win battles with bows and arrows against tanks and artillery. In this world of strife and competition, if a nation wants to survive, it must develop the latest techniques of civilised existence. And if anybody be under the illusion that under the protection of the mighty arm of the British Empire, we may hope to nurture for all eternity our spiritual "Vegetable" Civilisation, leaving the fruits of the "Machine" civilisation to the wicked Western nations, we may refer him to the thought-provoking dynamic book—*If War Comes*—by Prof. B. P. Adarkar. A perusal of this book will probably convince him that those who believe that under the protection of the British, we are absolutely safe, will find that they are living in a fool's Paradise. And if we do not pay attention to the alarming picture of the future so ably drawn up by Adarkar, we may, in no distant future, find ourselves under another set of masters.

In contrast to the "Vegetable" Civilisation of India, that of Western Europe may be called

FROM VEGETABLE TO MINERAL CIVILIZATION

" Mineral " because of the far larger use of minerals like iron, coal, copper and other materials which distinguish the West European civilisation from the earlier ones. The use of minerals has led to the present industrial age, and to the great revolutions in the standard of living, in communication, and other techniques of modern life. Even agriculture has profited immensely from the " Mineral " civilisation because by the use of modern agricultural machinery, and artificial (mineral) fertilizers, one acre of land can be made to produce now four times as much as it used to do formerly. The immense increase in the production of world's cereals is due to " Mineral " civilisation. About 70 years ago, the famous British scientist, Sir William Crookes predicted a wheat famine due to alarming increase in population. Today, the population has increased, but instead of there being a wheat famine, we have such a glut in the production of wheat that sometimes it has to be burnt as chaff.

Often while talking of the abuses of modern times, we are apt to forget the far greater abuses of ancient times. In previous epochs of history, civilisation mostly depended on Slave Labour. It has been estimated that at Athens, during the time of her highest glory, there were four slaves for each citizen. In Rome the proportion was far greater, because to the slaves captured in war, was assigned the task of cultivation, irrigation, ordinary household duties, in fact, all activities except fighting, ruling and other works classed as " Gentleman's Professions ". Slavery in one form or other continued till modern times, when the development of power from coal, water and petrol rendered the retention of the system unnecessary. In the most advanced countries like the U. S. A., power-development has been so great that we have " a horse in the form of electricity, steam and petrol " working for ten hours per day per man for all the 365 days of the year. Contrast it with countries like India which still depend mainly on man power, the total output of work is about twenty times less, because precise measurements have shown that the work output of a horse is ten times larger than that of the man, who can at best work for eight hours per day, and for not more than 300 days in the year. We have further to remember that only onethird of the total population is actively engaged.

There is a good deal of misconception about development of modern civilisation. It has been identified with the factory system, the capitalistic greed and social upheavals. To those, who are, in a position to survey the history of mankind tracing the evolution up to modern times, these features are but secondary, and should not be utilized to cloud the fact that " Mineral " civilisation enables man to live in far greater comfort, leisure, and security.

If the intelligentsia of this country be convinced about the necessity of adopting the " Mineral " civilisation of Western Europe, let us see how this can be done. Two things appear to be necessary. First, the genius of the people, and secondly, the natural resources of the country. By the genius of the people is meant their origin, custom, and faith. Without proper genius, even the richest land may fail to give any return. For example, let us take the case of the U.S.A., a country of enormous resources. The present settlers of European descent have developed it to the maximum extent and are living in it in plenty and comfort, and have leisure enough to devote themselves to the cultivation of arts and sciences on a scale not known in previous epochs of history. The Red Indians, however, who inhabited that continent two centuries ago never had the idea that their problems of food and living could be satisfactorily solved in the way the present European settlers have done, and the tribes were constantly carrying on with each other wars of extermination for the possession of fisheries and fields of maize and corn. A number of tribes, the famous Iroquois confederacy developed in contact with the Europeans a sense of political organisation and displayed a cunning in diplomacy which sometimes baffled even the most astute British and French politicians, but they never mastered the techniques of modern civilisation for developing the resources of their country. The result was that they were exterminated in the struggle for existence. This shows that mere possession of natural resources is not sufficient; the people should have the genius to appreciate the necessity for proper organisation for the development and exploration of the resources. We mention this fact especially because the philosophy of spinning wheel and bullock cart is still

an obsession with a great number of intelligentsia of this country.

Even when the people of a country have genius, they may be handicapped on account of the dearth of resources as is partly the case with the Italians and the Japanese. India, however, is fortunate enough in having sufficient resources in iron, coal, copper and other minerals. She can easily pass from the " Vegetable " to " Mineral " civilisation, provided the people develop the proper genius.

It is probably not so well known that the East has originated all those arts and crafts which are responsible for the greatness of the present European civilisation. It was in the East that copper was first discovered from its ores and used to replace tools made from stones. The East has used bronze which is far superior to copper for offence defence, and work, upto 1200 B.C. It was again the East which first showed that iron by special treatment could be converted into steel, a product far superior to bronze for fighting and tool making. Even the use of mineral coal originated in the East. It was Marco Polo in the 13th century, who told the Europeans that he had found the Chinese burning a kind of black stone as fuel. It was again from the Hindus and the Arabs that a knowledge of chemistry and astronomy spread to the West. The West developed for centuries these arts and crafts connected with metals and chemicals, and attained superiority over the East. If the East is again to regain her former position, she must take quick steps like Japan for passing from " Vegetable " to " Mineral " civilisation. As we all know, there is plenty of iron ore and sufficient reserve of coal in India, and so far as fuel, and iron and steel are concerned there has been no concerted effort to develop these for the requirements of the country, though it is admitted that the iron and steel industry has fairly grown up. We have already discussed in these very columns last month the problems of conservation of India's minerals and have given a fair consideration to coal. In another article entitled ' The problem of ferrous industry in India ' appearing in a subsequent issue the problem of iron and steel will be dealt with. It is our fervent hope that before long India will make up her mind to have her due place in the present-day civilisation, and will be treading that path with speed and energy.

Living Fossils*

Sunder Lal Hora

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It has been said that the laws of physics are unchanging with the flight of time, as for instance, a crystal formed a million years ago is precisely similar to one formed yesterday. The living organisms are, on the other hand, not immutable, but are continually evolving into other more and more specialised forms, though the rate of progress may be retarded or accelerated, and a given race of animals or plants may differ markedly from another in its plasticity. "Fossils" in human society are individuals or groups of individuals, who, in spite of the march of time, still retain old ideas, habits and customs; similarly among the present-day organisms there are certain types, which, on account of their primitive organisation and long geological history, bear closer resemblance to the animals or plants that lived millions of years ago and are now found in the fossil state, than to their contemporaries of the present day. The term fossil can, therefore, be used aptly for such relict forms.

It is a common experience that, as a rule, antiquated people and primitive tribes are found in remote and sometimes inaccessible parts of the country where the currents and waves of modern progress hardly reach to disturb their calm and placid existence. In the same way 'living fossils' among organisms possess a restricted distribution where for lack of competition and under favourable conditions of existence they have lived undisturbed for millions of years; their restricted distribution affords data to the biologist regarding their antiquity and to the geologist about the changes undergone by the various continents in relation to the oceans during the past ages. There can hardly be any doubt that at one time the living fossils, both in human society and among organisms, were more widely distributed but owing to competition by more specialised forms they were driven into remote parts or killed and for this reason are now found in small groups in widely separated localities. It would thus appear that progress is dependent on 'Struggle for Existence' and that "fossilisation" in a living state results from want of contact and lack of competition. It should, however, be understood that among organisms there cannot be a perfect static condition for they must either progress or retrogress and in accordance with this principle the living fossils have acquired certain features of specialisation in the course of their long histories which have enabled them to withstand the vissicitudes of the everchanging environment. Sometimes such features of specialisation so mask the primitive characters of an organism that it becomes very difficult to evaluate their family relationships.

From the cultural history of man and the geological history of animals it appears that progress results from contact with other organisms and is accelerated by catastrophies. I need not detail here the effect of Western Civilization on the present-day cultural features of India and the rapid strides made in the progress of human knowledge as a result of the Great War to illustrate these points.

At different periods of the earth's history the organisms living on it have been subjected to very trying conditions of existence and though such periods always resulted in an almost wholesale destruction of the fauna and flora, some sturdy organisms escaped these trials by seeking new habits, by adopting new habits or by retreating into areas away from the influence of catastrophic changes. In all cases the organisms had to adjust themselves to certain

* Summary of a Lecture delivered at the Indian Museum, Calcutta, on the 24th January, 1939, and published with permission of the Director, Zoological Survey of India. The views expressed in this article regarding the evolutionary history of a number of organisms are taken from standard authors and do not necessarily represent the views of the writer.

Fig. 1.—Geneological Tree of Fishes.

This figure is a photographic reproduction of a panel exhibited in the newly arranged Fish Gallery of the Indian Museum. The geneological tree of fishes is a copy of a similar exhibit in the American Museum of Natural History (After Gregory, *Nat. Hist.*, vol. 28, 1928).

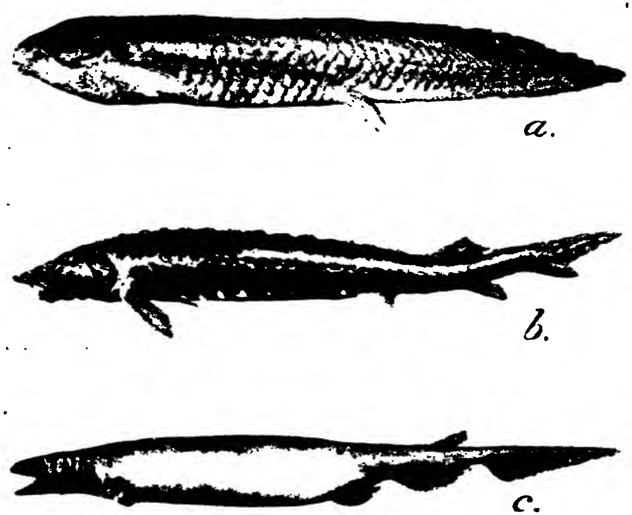

Fig. 2.—Three "Living Fossils" among Fishes.

a. The Australian Lung-Fish, *Epiceratodus forsteri* (Krefft); *b.* The Russian Sturgeon, *Acipenser güldenstädtii* Brandt and Ratzeburg; *c.* The Frilled Shark, *Chlamydoselachus anguineus* Garman.

All are photographic reproductions of specimens exhibited in the Fish Gallery of the Indian Museum.

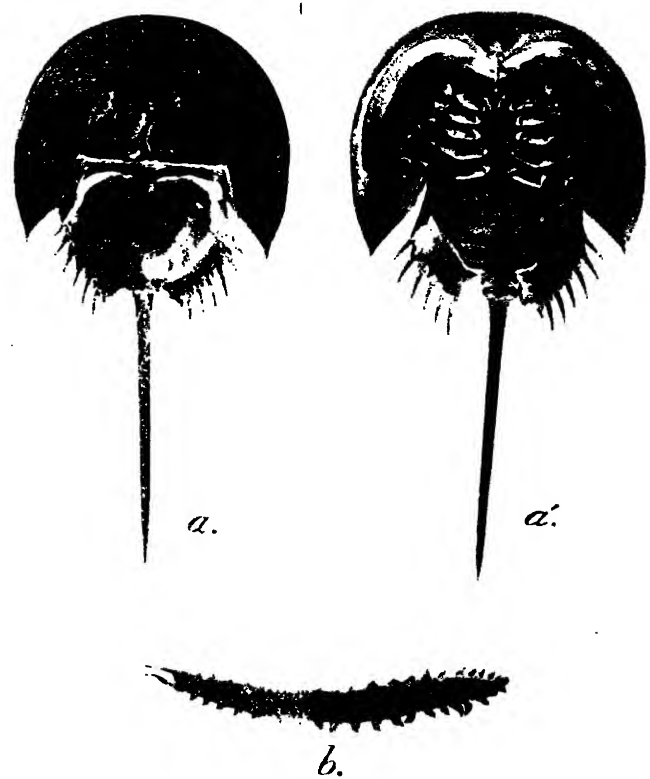

Fig. 3.—Two "Living Fossils" among Invertebrates.

a., a'. Dorsal and ventral views of a species of *Limulus moluccanus* Latreille from Chandipur, Balasore District, Orissa; *b.* The Indian Worm-like Arthropod, *Typhloperipatus williamsoni* Kemp.

Photographs of specimens in the collection of the Zoological Survey of India.

changes in their environment; thus none of the living fossils is without an impress of the conditions through which it had necessarily to pass. Take for instance the Dipnoan fishes, or the double-breathers, which breathe by means of gills and lungs. They flourished mostly in the Devonian and Carboniferous periods over three hundred million years ago and are at present represented by three genera, *Epiceratodus* in Australia, *Protopterus* in Africa and *Lepidosiren* in South America. They were once very widely distributed as their fossils have been found in all the continents. In India the Dipnoan remains are known from the Kota-Maleri beds of the Upper-Gondwana period.

It is believed that during the Silurian and Devonian epochs there were very strong currents in the sea due to widespread igneous activity resulting in earthfolding and mountain-building, and only such animals that lived at the bottom could escape their ravages. At that time the earlier fish forms, such as Ostracoderms and Arthrodiras, lived in the sea. Towards the end of the Devonian period even these forms died out altogether. Under these unfavourable conditions of existence certain fish-like forms entered large rivers for safety, but owing to periodic droughts had to face another set of trying conditions and responded to it by developing lungs for aerial respiration. This in short was the probable mode of evolution of the 'Lung-Fishes'. At the present time these fishes can tide over long periods of drought, sometimes lasting over a year, by lying in a torpid condition in cocoons manufactured by themselves. Though during aestivation the metabolism is greatly reduced the fish breathes air all the time for this purpose the cocoon is provided with a small aperture on the top.

The existence of these fishes at the present day has enabled zoologists to visualise the evolution of Amphibia from fish-like ancestors, which as judged from the palaeontological records, seems to have occurred about the same time as the evolution of the Lung-fishes. In the Dipnoi the internal skeleton is chiefly cartilaginous, but the upper and lower vertebral arches, the ribs and fin supports, all exhibit some superficial ossification. Thus, with the exception of some special features of their own, they combine characteristics in which they resemble now one, now another, of the other groups of Fishes, but at the same time they possess a few features, such as the presence of lungs, posterior nares and partially divided auricles of the heart, in which they approach the next higher class of vertebrates, the Amphibia.

In the scale of evolution the Lobe-Fins and the Ganoids are contemporaries of the Dipnoans. In the words of Gregory[1] the 'Old Ganoids'

"were the victorious mail-clad knights of old Devonian days who supplied the *vis a tergo*, the pressure from the rear, that drove our own ancestors out of water. Even before that time the Old Ganoids, like true pioneers of a strenuous race, had nearly exterminated the aboriginal inhabitants, the lowly Ostracoderms—grovelling creatures—which were Nature's first attempt to evolve a fish.

"Spreading into and subduing all the inland waters, the Old Ganoids, like the Mongol invaders of Europe, gradually deployed into many hordes or divisions. The histories of these divisions, in so far as it has been unravelled by the patient researches of ichthyologists, afford many instructive parallels with the histories of human dynasties and cultures. The members of each main division, branching off from the central stock at a given time and place, inherit from it a particular grade of organisation and a special 'culture' or way of life. What then shall they do with this inheritance, when they are set off by themselves, a new colony in some far-off place, where they are safe from the competition of the present inhabitants and the unexpectedly severe climatic aberrations of a new environment? Fish and men respond to this situation in much the same way. Some races rapidly adapt themselves to the new conditions. Finding some favourable line of advance, they recklessly sacrifice their old equipment and old ways, force themselves into the new economic niche, and eventually become so highly specialised in its ways that they are fit for nothing else, or at best can meet new changes in the environment only by further specialisations in the same general direction. In other words, starting in as conservatives, they skip the progressive stages and soon develop into radicals and freaks. Again and again many of the descendants of the Old Ganoids left the straight and narrow path of their ancestors, gave up the free life of buccaneers in the open waters, and slunk away to become mud-grubbers, like the sturgeons and carps and catfishes, or to take refuge in holes and crannies and become slinking ratlike pilferers, living like eels in foul waters. Not so the old guard, the saving remnant of the Old Ganoids. Yielding as slowly as possible to an insidious pacificism, they asked and gave no quarter, and age after age somehow managed to give rise not only to new hordes of more or less degenerate descendants, but to the true viking strain, that after millions of years finally flowered out in the highest of the Teleosts, the basses and the mackerels."

[1] Gregory, W. K.—A Tour of the New Hall of Fishes. *Nat. Hist.*, XXVIII, p. 5 (1928).

The Ganoids exhibit their greatest development in Palaeozoic, Triassic, and Jurassic formations; and from the base of the Cretaceous system upwards they become more and more replaced by the bony fishes. The few still existing Lobe-Fins and Ganoids, such as *Polypterus*, Sturgeon (*Acipenser*) and Gar-pike (*Lepidosteus*) live either exclusively, or at least partly, in fresh water, while the large majority of the earlier fossil forms occur in purely marine deposits. Like the Dipnoi, these fishes also entered fresh waters in the Devonian period and developed the habit of aerial respiration to tide over periods of drought.

The distribution of the present-day Ganoids is curiously limited, as they are almost exclusively inhabitants of the Northern Hemisphere and are essentially freshwater forms, although some Sturgeons are found in the sea. At one time they were widely distributed and from India their remains are known from the Kota-Maleri beds and the Infra and Inter-Trappean beds of Deccan. Their organisation is intermediate between the cartilaginous and bony fishes, and they provide valuable data to zoologists to decipher the lines of evolution of the modern bony fishes.

The living sharks are the survivors of a very ancient and sturdy race. Most of the present-day genera of "Sharks," however, date back to the Cretaceous or the Tertiary periods, but there are two types which take us much further back and, owing to certain primitive features in their organisation, are termed "Living Fossils." One of them is the Frilled Shark, *Chlamydoselachus anguineus*. In its organisation it is a comprehensive type, for it embodies not only primitive characters, but also those that are highly specialised or unique. The frilled shark has been taken only in Japanese waters and off the western coast of Europe. Since it is quite rare even in these restricted localities, it seems to have a precarious hold on existence.

From among its several primitive features I shall only refer to the type of teeth found in this shark; they are of the 'cladodont' type, that is, they are formed by the fusion of simple denticles. At the angle of the mouth the scales grade into teeth, thus indicating the origin of teeth from scales. In the evolution of the teeth of sharks one of the denticles becomes larger at the cost of others and ultimately we get a central cusp without the lateral denticles.

The other family of sharks to which I wish to refer is the Holocephali—the Chimaeras or the Rabbit-fishes. The existing representatives of the Holocephali are only an insignificant remnant of a former much more extensively developed group of Cartilaginous fishes (Elasmobranchs) which first appeared in the Lower Jurassic. While agreeing with the Elasmobranchs in many important respects they show an advance in the presence of an autostylic skull and an operculum. The last two characters they share with the Dipnoi, a very ancient group of fishes. The Holocephali and the existing Elasmobranchs may thus be considered as having arisen from the same primitive stock along diverging lines of descent.

The Cyclostomes, comprising Hag-fishes and Lampreys are highly specialised, in some respects degenerate, members of a very ancient group. They are fish-like animals, but are characteristised by the absence of jaws and limbs. In these respects they show close affinities to the Ostracoderms and attempts have been made to show their relationships with the "King Crab"' to which reference will be made presently, and with the larval "Sea-Squirts." Still lower down in the ancestry of the vertebrates is a small worm-like, burrowing animal, the *Amphioxus*, in which there is no skull and the backbone or the notochord extends forward to the anterior end. This and the other lower Chordates, such as *Balanoglossus* and Tunicates, which persist up to the present day, are of very great importance in tracing the probable evolution of the higher Chordates and for connecting them through their development with the lower organisms.

Most of the 'Living Fossils' are aquatic, for water provides a fairly stable *milieu* for existence, but I shall now briefly refer to two terrestrial vertebrates which are striking examples of 'Living Fossils.'

The New Zealand Tuatara, *Sphenodon* or *Hatteria*, is a lizard-like reptile with a well-developed laterally-compressed tail. The upper surface is covered with small granular scales, and a crest of

compressed spine-like scales runs along the middle of the dorsal surface. The lower surface is covered with transverse rows of large square plates. It is the sole survivor of an ancient and primitive order of reptiles which attained its maximum development in the Trias. In its general build it shows resemblance to true lizards on the one hand and to higher reptiles, such as crocodiles and alligators, on the other. Among mammals, the Duck Bill and the Spiny Ant-Eater are unique, in so far as they discharge the eggs at an early stage of development enclosed in a tough shell. This and several other features of their organisation distinctly show the reptilian ancestry of mammals. Like the other living fossils they also possess a restricted distribution, being confined at the present-day to Australia Tasmania and New Guinea. Triconodont type of teeth, most probably allied to those of Duck-Bill and Spiny Ant-Eater, have been found in the Upper Triassic and Jurassic rocks of Europe and America.

Reference may be made to a few relict forms among the invertebrates. In connection with the probable ancestry of fishes, reference has been made to the King-Crab or *Limulus*. The living species of *Limulus* occur on the eastern shores of North and Central America and Asia. The genus first made its appearance in the Trias. At the present day *Limulus* is included among Arachnids, a group of animals comprising spiders, scorpions, mites, ticks, etc. Whereas most of the Arachnids are terrestrial and breathe atmospheric air direct, *Limulus* retains its water breathing habit, and, in the features of the abdominal appendages some traces of the characteristic structure of the primitive crustacean stock from which the Arachnida originally sprang.

The embryo of *Limulus* is without a caudal spine and swims freely by means of its abdominal appendages. With its well marked lateral eyes, segmented abdomen and body divided into median and lateral regions by longitudinal grooves, it presents considerable resemblance to a *Trilobite*, a fossil crustacean. The *Trilobite* crustaceans originated in the pre-Cambrian times and their remains are very abundant in the oldest fossiliferous strata. According to modern researches the group is closely allied to a kind of water flea, known as the Branchiopoda. *Limulus* is thus an important 'Living Fossil' which enables us to trace the origin of the spiers and scorpions from water-fleas and gives a clue of the probable origin of vertebrates from Arachnid ancestors.

Another very important 'Living Fossil' is the small worm-like *Peripatus*, the only representative of the aberrant arthropod class Onychophora. Though its general resemblance to an earthworm is very striking, its clawed appendages, the formation of the jaws by the modification of the anterior limbs and the presence of tracheae for respiration clearly show its affinities with insects, centipedes and millipedes. The superficial resemblance to worms is further strengthened by the structure of some of its internal organs. All the same there is no doubt that *Peripatus* is to be regarded as the most primitive of the existing Arthropods.

The various species of *Peripatus* are all terrestrial, and are found in damp localities, under bark, or dead timber, or stones. The genus is known from South America, Africa, India, Malaya, New Britain and Australasia. The Indian species was discovered in 1911 in the Abor Country and was found living under stones. This discovery helped to show the previous extent of distribution of these primitive creatures and further it indicated that, like the Dipnoi and the Ganoids, India served as a route of migration for animals from the north-east to Africa and South America.

Among the small animals that have existed for long ages are the Branchipods of the genus *Lingula*. They are found in some of the oldest rocks and attained their maximum development in the Silurian and Devonian periods. The morphological features of this 'Living Fossil' have enabled zoologists to trace the relationships between the earthworms-group of animals (Chaetopoda) on the one hand and sea-mosses (Polyzoa) on the other.

The mollusc *Spirula* is a survivor of an ancient order of Cuttle-fishes, all the other forms of which are now extinct. Its life-history and structure have revealed the ancestry of the allied molluscan forms. Though *Spirula* bears a resemblance to the present-day Cuttle-fishes and is grouped with them, its shell is of spiral form, the turns of the spiral, however, are not in close contact.

LIVING FOSSILS

It is sufficiently clear that 'Living Fossils' among animals are really some of the most important types for the students of Organic Evolution. Whereas true fossils may enable us to understand some of the changes undergone by organisms in the course of their evolution, without the study of the soft parts of the "Living Fossils" it would not have been possible to fully grasp the value of several of the true fossils. Similarly, to trace the cultural history of man it is not only necessary to excavate old ruins and to study the archaeological finds recovered therefrom, but much progress can be made by an anthropological study of the ancient races and tribes before they gave way to the tide of modern civilization. Generally among people of advanced ideas it is regarded as highly derogatory to be termed a fossil, and by many this appelation may even be considered as an insult. From what has been stated above about the utility of "Living Fossils" I would plead that in human society a certain amount of indulgence should be shown to "fossils", for if their views are properly studied we may find ideas in them to solve some of our present-day troubles. Very often it is forgotten that specialisation or modernisation, like everything else, has its drawbacks and among animals death is the penalty that has to be paid for over-specialisation. Paradoxical as it may seem, only the most lowly organised animals, the Protozoa, are immortal.

Coal in India*

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ALTHOUGH the term *coal* originally referred to charcoal, they are now generally applied to the black, solid fuel which occurs in the rocks of the earth. Coal is, in fact, as true a rock as the sandstones and shales with which it is interbedded, and with which rocks it constitutes the strata we commonly call "Coal-measures". Those areas of the ground where coal-measures with workable seams of coal occur are known as "Coalfields". In the Indian coalfields the coal-measures are usually composed of successive beds of conglomerate, sandstones, shales and coal seams which vary in thickness and quality. All these strata represent sediments which were carried by flooded rivers and deposited in the quiet waters of fresh water lakes, or in estuaries, or even in the sea.

In the process of transportation the coarse material, such as pebbles and sand, were sorted from each other and from the finer silt and clayey matter, while the buoyant vegetable debris, leaves and logs, were floated further. Where the water-logged plant material sank in muddy water it would be mixed with earthy material and ultimately become impure coal, but when tree trunks and woody material drifted into and settled in clear water the organic matter would be converted into coal of great purity. It is necessary that air should be excluded if vegetable matter is to be converted into coal, and, under the conditions indicated above, this conversion appears to have been rapid in the case of many Indian coal seams. Peat and lignite or brown coal appear to represent stages in the transformation of plant debris into true black coal and anthracites. Exclusion of air, pressure due to covering strata and, to some extent, the ageing due to lapse of time, are important factors in producing the chief types of coal. The amount of impurities in these various types of coal offers a means of recognising the quantities of coal of each type of coal.

* Based on lecture delivered at the Indian Museum, Calcutta.

COAL IN INDIA

Constituents and Characteristics of Indian Coals

Conditions suitable for the formation of coal have recurred at different geological epochs since the first terrestrial floras appeared in Palaeozoic times. In the Indian region there were two particularly important coal-forming periods one, the more important, about 150 to 200 million years ago when the Gondwana coalfields of the Peninsula were laid down in wide river valleys, and the other, roughly 50 to 60 million years ago when the Tertiary coalfields of Assam and the Punjab were deposited under marine conditions. In almost all these coal measures the seems have a bedded structure and show alternate layers of bright and dull coal, while a charcoal-like substance often occurs in the bedding between the layers of bright brittle coal and the laminae of dull coal. The names *vitrain, durain* and *fusain*, are now commonly used respectively, for the bright coal, the dull coal and the charcoal like soot. Proximate analyses of these three coal constituents show that *vitrain* generally contains the smallest amount of impurities and the largest quantity of volatile matter and moisture, that *fusain* has the highest percentage of fixed carbon, and that *durain* usually contains the greatest quantity of ash. On exposure and handling the bright brittle coal breaks up into small cubical fragments which go into the smaller slack coal, but these brittle fragments do not yield dust unless they are actually crushed.

It is believed that fires due to spontaneous combustion in coal mines and ships bunkers result from the oxidation of powdered *vitrain* which has accumulated and been exposed to warmth in a damp unventilated position. *Fusain* or mineral charcoal is normally a minor constituent in Indian coals, but owing to its pulverulent condition and the ease with which this sooty substance forms dust, it is considered as a dangerous material when present in appreciable quantities in a dry mine. *Durain* or dull coal, due to the intimate admixture of earthy matter, grades into carbonaceous shale and has a higher specific gravity then bright coal. It can thus often be freed from bright coal by permitting the *durain* to sink in a suitable liquid in which *vitrain* can float. Although a high-ash coal must always be inferior to similar coal low in mineral impurities the greater harmful effects of high moisture should also be considered. It is not too much to say that a low-moisture coal with 55 per cent. of ash may often yield a strong coke, while it is rare for a coal with over 5 per cent. moisture to coke even if the ash percentage is small.

Coalfields and Coal Reserves in Indian Empire

As already stated the most important coal-measures in India are: (*i*) the Gondwana (Permian) coalfields of the Peninsula, such as Raniganj, Jharia, etc., and (*ii*) the Tertiary (Eocene) coalfields of Assam, the Punjab and Baluchistan. In most of the Gondwana coalfields the coal-measures are practically undisturbed and gently inclined and contain several seams exceeding 10 to 12 feet in thickness. The Tertiary coal measures of Assam on the other hand are bent and dislocated and the seams are steeply inclined. There are exceptions in both cases, for example, the Gondwana coal-measures in the Darjeeling Himalaya are crushed and overturned while the coal seams on the Assam plateau are practically undisturbed and gently inclined. As a rule the Gondwana coals belong to the true black, bituminous class of coals while the Tertiary coal seams contain lignitic coals with high percentages of volatile matter.

In calculating the reserves of Indian coal it has generally been our habit to consider seams with a thickness greater than 4 feet, an ash content below 20 per cent. and occurring within a depth of 2,000 feet from the surface. These are far stricter conditions than those adopted for the Coal Resources of the World at the International Geological Congress, held in Canada in 1913, where half the above thickness and twice the depth mentioned were permitted. On the basis I have stated the coal resources of India, in terms of statute tons, have been computed at 24,000 million tons. The reserves of good quality coal, based on an ash percentage below 18 and included in the above total, are estimated at upwards of 6,000 million tons. The reserves of coal capable of yielding coke of metallurgical quality, and also included in the totals above, have been calculated at somewhat under 1,400 million tons and restricted to the Gondwana coalfields in the Damodar basin. It is of interest to record, however, that probably more than 1,000 million tons of strongly coking coal, averaging less than 8 per cent. ash but unfortunately rather high

in sulphur—sometimes exceeding 2.5 per cent. sulphur—occur in the Tertiary coalfields of Assam. These coals have so far been excluded from estimates of coking coal reserves because they are believed to be unsuitable for metallurgical purposes. Their average sulphur percentage has yet to be ascertained and their distance from the existing industrial centres has not rendered their investigation very pressing, but in years to come these coals may prove of considerable value to the Governments of Assam and Burma, and possibly Bengal.

Development of Coal Mining and Geological Surveys in India

Although it is practically certain that coal had been discovered in India before the time of Warren Hastings there is no record of any coal mining in this country until 1774. In that year coal mines were opened on the outcrop of what is now called the Dishergarh seam near Sitarampur, and in 1777 a project was under consideration to erect ironworks in the same vicinity. The coal industry thus initiated was unfortunate and appears to have become defunct when Government interested itself in the opening of a coal mine at Egara, near Raniganj, in 1814. This official interest was due to the need for coal for the steamers which were being introduced for river navigation between Calcutta and Allahabad. In 1837, when the first Committee for investigating the Coal and Mineral resources of India submitted their report, coal had been discovered in Assam, Bengal, the Central Provinces and elsewhere and English miners had been engaged to open and work the mines in a practical, methodical way. A few years later, in 1845, the Committee for the Investigation of the Coal and Mineral resources of India submitted a further report, drawing attention to the difficult nevigation of the Damodar river and the uncertainty even during the rains, of the coal supplies to Calcutta. Their recommendation for "a Geological Survey of the Coal Formation of India" to provide the necessary information on which practical mining should operate was immediately adopted and the geological survey of the Damodar valley coalfields was begun in 1845 by D. H. Williams, who had been recruited from the Geological Survey of Great Britain.

The Raniganj coalfield, including the so-called Burdwan coal mines, was surveyed in 1845-46, the Ramgarh coalfield in 1847, and the Hoharo or Karanpura field was being examined by Williams in 1848, when he died of jungle fever. The initial geological surveys of the coalfields of India, by various officers of the Geological Survey of India, had been extended to almost all parts of India when the Indian Museums in Chowringhee was thrown open to the public in January 1877. Meanwhile the East Indian Railway, which had been opened between Howrah and Raniganj in 1855 and extended to Barakar in 1865, was being rapidly carried up the Ganges valley. Already in 1878 the annual coal production in India was over a million tons, and four times this amount in 1897 when the Jharia coalfield was first tapped by the railway. The total annual production of 1897 was quadrupled in the next 16 years and exceeded 16 million tons in 1914. The Bureau of Mines Inspection which was associated with the Geological Survey of India till 1902, changed its name to the Department of Mines in 1904, and finally established itself at Dhanbad in 1909 when the Indian coal industry was already recognised as yielding the most valuable mineral in India.

Method of Coal Mining Adopted for thick Seams in Indian Mines

The method of entirely removing all the coal in a seam leads to serious subsidences of the surface and dangerous conditions underground, when applied to seams of over 4 feet in thickness, unless the voids are filled up with debris. This "long wall system has been, and is still, used in some Indian collieries where the conditions have proved suitable and, at least partial, packing or stowing of the voids or goaves has been carried on. In general however, the seams worked in Indian collieries are relatively thick and, from the earliest days of coal mining in this country, the socalled "pillar and stall" system of working was adopted. It has proved satisfactory when efficiently conducted. Unfortunately the pillers of coal which are left to support the superincumbent strata have often been too small and in consequence have collapsed and led to subsidence and losses of coal by underground fires and by flooding from river beds, or, adjacent

mines. Experience has shown the importance of leaving large coal pillars in most cases, although this entails leaving more coal behind in the mines in a solid condition. There is a great temptation in periods of bad trade to extract or rob coal from these pillars. In this manner the old conditions of danger from fires, collapses and floods have been re-established and have, sometimes, involved the loss of an entire colliery because the fires could not be fought or satisfactorily sealed-off when they occurred in abandoned workings.

Early experience, based on the "Square Work" system of South Staffordshire, where the Thick Coal is also subject to spontaneous combustion, showed that the underground workings could be made into separate compartments or panels by leaving barriers or ribs of coal between groups of pillars. This "panel" system has proved of value time after time in sealing off outbreaks of fire, due to the oxidation of slack coal in old working, where the ventilation is bad and dangerous gases have possibly accummulated. It is to be remembered that by leaving barriers of coal still larger amounts of solid coal have to be left for safety and the so called percentage extraction thereby reduced. Furthermore, the sealing-off of a panel does not ensure that the fire thus isolated in it will quickly die out. Some fires are known to have smouldered for months and led to very serious complications by collapse and by eruptions of poisonous and explosive gases. To overcome all possibility of danger in this way and also to recover the solid coal left as pillars a few Indian colliery companies adopted the method of packing the voids by hydraulically stowing them with sand or other rock debris. This has entailed additional costs both for securing the sand and in pumping back the water used, but it is everywhere admitted that it excludes all possibility of fires and collapses and thus ensures greater safety in working. Today the necessity of packing is not denied, but there are differences of opinion regarding the relative merits of the different methods of stowing by hand, by mechanical means, by compressed air or by water. It is necessary to add that those who have studied the problem are satisfied that adequate sand supplies are available in the Damodar river for the Jharia coalfield requirements.

The Growing Responsibility in Developing Coal Mines

In 1909 when the value of the coal produced in India exceeded that of any other mineral raised in this country India also became the largest producer of coal among the British overseas dependencies. Both these positions have been maintained since notwithstanding the substantial increase in coal production in the colonies and of other minerals in India. In 1909 the coal production was nearly 12 million tons at a pits mouth value of Rs. 3/8 per ton, while the death rate in coal mines was barely one per thousand of the 100,000 odd persons engaged. In 1919, however, when the output had increased to $22\frac{1}{2}$ million tons at an average pits mouth value of Rs. 4/8 per ton, the death rate had risen to 1.41 per thousand of the 2,00,000 odd persons employed in coal mining. Government concern at this increased danger in coal mining had already been shown by the engagement of Mr R. I. Treharne Rees in 1918 to investigate and report on the methods of coal mining in India. His report, received in 1919, was submitted to the Coalfields Committee of 1920 which had been set up to examine it and advise what means might be adopted to improve the situation. The Committee were not in complete agreement in their recommendations, but were of the opinion that no improvement in the wasteful methods of extracting coal could be expected without State interference. In the circumstances the only action that could be taken was to tighten up the application of the mining regulations through the Mines Department to at least ensure greater safety for those employed. The success which has attended these official efforts may be seen in the diminished death rate since then, and even in the disastrous year 1936 it did not exceed 2.39 per thousand as against 1.53 in the previous year and 1.09 in 1937 as compared with an average of 1.16 in the period 1924-28 and 1.08 in the period 1929-33.

The tendency towards over-production which appeared in 1919 have since developed and been accompanied by lower selling prices, which in turn has entailed lower working costs. To reduce expenses and endeavour to increase production under the circumstances which are generally met with in mining, such as poor illumination, precautions against gas and coal dust, difficulties with

labour, floodings and epidemics, could have only one result—the further deterioration in the methods of mining the coal. This has been abundantly proved, first by the explosions, including the coal dust explosion in Parbelia colliery in 1923, which led to the setting up of an official Coal Dust Committee in 1924 and finally to the series of disasters in 1936 when the Coal Mining Committee was appointed to devise means for securing greater safety in working Indian coal mines. The members of the Coal Mining Committee were actually visiting in the neighbourhood of Poidih colliery when that explosion of coal dust occurred there and were able to visit the place immediately after and actually take part in the efforts for rescue.

Endeavours to Solve Problems of Danger and Trade Generally

In 1925 the Coal Committee under Sir Frank Noyce investigated all the factors which might prove valuable to encouraging the export of Indian coal, and after making recommendations were obliged to conclude that the main effort should come from the coal trade itself. This Committee was the means of establishing the Indian Coal Grading Board, and thus recognising the importance of proximate analyses and calorific value as indicating the true quality of a coal. In spite of this, consumers frequently insist on purchasing coals from definite seams and collieries, notwithstanding the fact that the quality of coal in a seam varies, not only in the adjacent but also in the different layers of coal which constitute the seam at any place. The data collected by the Coal Dust Committee between 1924 and 1932 have also been made available although their tests have rightly not influenced general opinion that "........more stringent precautions with respect to the danger from coal dust should be applied in gassy than in non-gassy mines." With regard to their experimental evidence, which chiefly relates to coal dust specially made by powdering coal samples, they regard all coals of commercial quality as able to propagate an explosion under suitable conditions if sufficiently finely ground, and they considered low ash coals with a high volatile matter percentage as more explosive under similar conditions than other coals. The coal dust explosions in Parbelia and Poidih in the Dishergarh seam would appear to support these conclusions, but it must be stated that a careful examination of the actual dust in the mines, both under the microscope and by proximate analysis in addition to explosion tests, will yield more valuable information than at present exists regarding Indian coal mine dusts.

The discussions on the subjects of the prevention of coal dust explosions in coal mines, have resolved themselves into whether coal dust is rendered inert more efficiency by diluting with stone dust or by damping with water, and in this connection the question of using liquid mud or even lime-wash is also worthy of more careful consideration as the white washing will improve the illumination below ground. Finally, mention must be made of the recommendations of the Coal Mining Committee in 1937 and the Memorandum it has drawn from the Indian Mining Association. The Committee have put forward an immense scheme, but even this did not satisfy two of its members who consider that the entire coal industry should be State managed. The Indian Mining Association consider that the present unsatisfactory condition of the coal industry is due to Government possessing State collieries and in virtually fixing the price of all coals through the Chief Mining Engineer of the Railway Board to the advantage of Government. Both these valuable contributions are now under careful consideration and there is little doubt that history will repeat itself after the century of coal mining which has now elapsed since 1837 when the first Coal Committee submitted its report.

The Future of the Indian Coal Industry

There is no substitute for coal in India. It remains the most important mineral substance mined in this country. Estimated at Rs. 5/- per ton the 25 million tons produced in 1937 is valued at seven and a half crores of rupees. I have shown from examples like Warora and Mohpani and others, where collieries have been abandoned, that barely 25 per cent. of the coal in the seams has been recovered in some Indian mines. And it is not a serious over-estimate to say that in the Jharia coalfield, the store house of India's good quality coking coal, one ton of coal is being left in the mines, and unrecoverable at present, for every ton brought to the surface. Since mineral assets once

wasted are irreplaceable it is evident that calculations of resources are false if these reserves are not all available. Attention has been drawn to this question of conservation, and it is a joint problem with that of safety in mining which is now receiving consideration.

More than half the present output of Indian coal is consumed by the railways, chiefly for locomotives, and by the iron and steel industry, largely as coke. The remainder, which includes wastage and the coal used at collieries, is available for all other purposes—mills, factories, works, bunkering, export and domestic fuel. Although the demands of the two greatest consumers, the railways and the iron and steel industry, will increase gradually, there are possibilities of economy by electrification of the former and use of waste gases in the latter, whereby their requirements may often decrease. In view of the coalfields of South Africa, Australia, Sumatra and Japan, I think India has done very well already to secure markets on the Indian Ocean seaboard for over one and a half million tons of coal. On the other hand, a domestic consumption of two to three million tons for household fuel among 300 million people is remarkably small as an annual total. Notwithstanding the general poverty of the population it is my opinion that if small parcels of say 14 lbs. of good smokeless fuel were generally available at one anna a parcel a very much longer demand for this fuel would arise.

The subject of great electrical stations in and about the coalfields has been one of great importance, as it is anticipated that power as cheap as one pie per unit should be available if in present-day stations the cost of generating power is one pice per unit. Although these power stations may lead to a considerable increase in the development of industries like aluminium and others for manufacturing purposes they may ultimately reduce the production of coal by the supply of electricity to present day buyers of coal. It would thus seem to me that the greatest future for the Indian coal industry is in preparation of cheap smokeless fuel for household use and in recovering the primary tar and gases in the process of distillation. The tar would be far more suitable than coal for hydrogenation at moderate temperature and low pressure. By this process the primary tar can be made into expensive products, such as benzine in time of peace and, when necessary, into toluene for the preparation of explosives.

Solar Control of the Atmosphere*

M. N. Saha

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It is a matter of common knowledge that weather and climate, so important to human life, are solely controlled by the sun. The understanding of this control mechanism has presented an eternal problem to mankind. In ancient communities, there were 'weather prophets' whose duty it was to foretell the weather and if possible, to control it with magic. In later times, their place was taken up by astrologers who are still found in many parts of the world issuing weather forecasts for the year.

Scientific study of weather and climate dates from the time of discovery of the barometer by Torricelli but from the very nature of things early meteorology could not find out a Newton, and it was realized that meteorological data must be

* Based on the Presidential Address delivered at the last annual meeting of the *National Institute of Sciences of India*, held at Lahore.

patiently collected, classified and analyzed by a world-wide survey, before we can have any inkling of the secrets of the puzzling phenomena presented by meteorology. For this purpose, meteorological surveys have been organized almost by every state and a system of short and long range forecasting has been undertaken. But short-range forecasting owes, whatever success it can claim, more to powers of quick transmission of news which is rendered possible by modern discoveries in physics than to any profound insight into the nature of the problems involved. But what would really benefit mankind is a system of successful long-range forecasting, say 6 months or at least 15 days ahead. The meteorologist has not yet succeeded in this task. However, in recent years Franz Baur in Germany and Multanovsky in Russia have developed methods for medium-range forecasting which appears to have attained a certain amount of success. Their methods are based on combination of synoptics and statistics, and in Franz Baur's method, atmospheric conditions at a height of 5 km (1.6 km 1 mile) are supposed to control the ground weather for the next 10 days. But no physical basis has yet been found as to why this should happen.

Formerly meteorologists thought that ground weather was controlled by the direct heating of the surface of the earth by the solar rays. So they neglected the study of the upper atmosphere. But in recent years, upper air surveys have been receiving greater and greater attention. There are the spectacular stratospheric flights, exploration of the upper atmosphere by radio-meteorographs, instruments which are carried in balloons and signal weather conditions upto heights of 30 km by radio. In view of the prospective use of the stratosphere for air travels and the use of still higher regions for radio propagation, probably the need will be soon felt for a better knowledge of not only the stratosphere but also of the still higher regions. Here photochemical action of solar radiation on the atmospheric gases plays the chief part. So we must have a good knowledge of the radiative properties of the sun and the constituents of the upper atmosphere, and the action of solar radiation on them which ultimately controls the ground weather.

The Ozone Screen

Our knowledge regarding the radiation from the sun is particularly defective in the ultra-violet region because the solar spectrum is abruptly cut off below 2900A. In 1881 Hartley showed that this abrupt termination of the solar spectrum below 2900A is due to a small amount of ozone present in our atmosphere. But ozone is not distributed according to the laws of hydrostatics as in the case of other gases in the atmosphere, but was shown by Fabry and Buisson in 1913 to be localized in the upper regions. A worldwide survey of the ozone content of the atmosphere has been initiated by Dobson, Götz and Meetham. The amount of ozone present in the atmosphere is found to be not more than 3/10 cm of the gas at normal temperature and pressure, spread over the atmosphere layer from 20 km to 50 km, having a maximum density at about 30 km, but the amount undergoes variations which are clearly connected with meteorological conditions. The ozone itself is not an original constituent in the sense oxygen or nitrogen is, as in that case, instead of occurring at a height, it would have settled down at the bottom. It has been found that ozone is produced by photochemical action of the sunlight on the oxygen of the atmosphere in a way which is not yet completely elucidated.

Aurora (Active Sun)

We all know that there is no sunlight for about six months every year in the polar regions. During these long winter nights the sky is frequently illuminated by brilliant flashes of light, called aurora or polar lights. Long ago, it was found that the brilliancy and frequency of these auroral lights were not constant from year to year, but varied in the same way as the spots of the sun, the period being nearly 10.32 years, roughly known as the 11 year period of the sun.

The close connection between sunspot activity and occurrence of aurora led Birkeland to the view that auroral phenomena were probably due to injection of streams of electrons coming straight from the sun and striking the atmosphere of the earth in a narrow jet, a view which he further confirmed by laboratory experiments which has been repeated in recent years by Brüche. The streams of electrons on their entry into the atmosphere, are deflected by

the earth's magnetic field and are focussed round about the magnetic poles. Paulsen, on the other hand, thought that the swarm of electrons which produce aurora, does not come direct from the sun but are produced by the ultraviolet light of the sun acting photochemically on the constituents of the upper atmosphere.

The spectrum of aurora contains a prominent green line, the origin of which was unknown for a long time. This green line was ascribed to a hypothetical element, even lighter than hydrogen, called geocoronium by Wegener. But when Moseley definitely proved that there was no place for such an element in the periodic table, it was found necessary to look for the origin of the line from amongst the known elements. This line was later found to be given by the oxygen atom when it is in a metastable condition by what is known as the forbidden transition from one metastable level to another. This discovery shows that oxygen, contrary to hydrodynamical conceptions, is present in the auroral regions (80 km.-400 km.) in the atomic state and in a peculiar state of excitation. Further examination of the spectrum of aurora reveals lines which have been identified with those of forbidden lines of atomic nitrogen. Thus spectroscopy has given us knowledge of the peculiar physical conditions prevailing in the auroral regions.

Luminous Night Sky (Quiet Sun)

It is a well-known fact that if one observes the sky from the countryside far away from the city lights at the dead of night, the starless parts of the sky do not appear to be as dark as one finds himself in a light-tight room but appear to possess considerable luminosity. This must originate from the upper regions of the atmosphere for it is observed even at stations far removed from the magnetic poles, hence the luminosity must be due to other cause besides artificial stimulation by electrons which gives rise to aurora. The spectrum of the luminous night sky shows the same green line of oxygen and certain other band lines which have been identified with those of nitrogen. The important difference between the spectrum of the night sky and aurora is that, in the latter, bands due to ionized nitrogen predominate and lines due to uncharged nitrogen molecules are very feeble, whereas in the former case, the negative bands are faint and sometimes even absent but band lines due to neutral nitrogen molecule are extremely strong. The origin of the luminescent night sky must be traced to the fact that at these height sunlight is absorbed by the atmospheric gases in the day time and stored in some way and is re-emitted at night. A closer examination of the phenomenon, therefore, promises to throw much light on the nature of the solar radiation, because the night sky phenomenon can be due to no other cause except the action of the ultraviolet rays of the sun below 2000A on the constituents of the upper atmosphere.

Thus it is clear that the luminescent night sky, and the aurora, both represent optical excitation of the constituents of the upper atmosphere but that under different conditions. The former is a purely photochemical excitation by a normal sun, the latter is due to an *active* sun, and further complicated by the peculiar way in which the optical excitation is effected through the agency of electrons which according to one view, come directly from the sun but according to the other view, are photoelectrically liberated in the outer regions of the sunlit parts, but are deflected by the field of the earth towards the magnetic poles.

Terrestrial Magnetism and its Variation

The solar control of the part of the magnetic field of the earth due to external causes is illustrated by disturbances of two types. An erratic one called magnetic storms was first observed by Celsius in 1741, who found that the coming of the aurora was heralded by a certain amount of restlessness of the magnetic needle. Magnetic storms have been found, in general, to occur in greater intensity and frequency simultaneously with periods of solar activity indicated by spots and aurora. The second type of disturbance is of more regular nature and shows a diurnal and a monthly period. At sunrise, the north-seeking pole of the needle is slightly east of its position, at noon, it points approximately to its mean position, towards sunset it moves to the west and regains the mean position again at midnight. The daily disturbances of this type are caused by the horizontal movements of the electrons (*i.e.*

electric current) in the upper atmosphere across the vertical field of the earth's magnetism.

Ionosphere

About three years after the famous experiments of Marconi in transmitting electro-magnetic waves from England to America, Kennelly and Heaviside almost simultaneously proposed that the upper atmosphere contains a number of free electrons which form a sort of metallic shield about the earth, reflecting wireless waves and thus keeping them confined within a narrow shell about the earth. At the present times, it is known that the electrons which act as reflectors of wireless waves are stratified in different layers of which two are permanent. They are known as E_1 (at about 100 km. height) and F_2 (at about 200-250 km.) Methods have now been perfected for finding out the night and day variations of the height of these layers and their maximum electron concentration etc. In addition to these permanent layers there are also subsidiary ones. There were long controversies regarding the origin of these layers. Birkeland proposed that these layers were formed by electrons coming direct from the sun while others maintained that they were due to electrons liberated by the ionizing action of ultraviolet sunlight. The problem was solved in a decisive way during the total solar eclipse of 1932. Experiments showed conclusively that at least in the E and F_1-regions the electrons were produced by the ultraviolet sunlight because as soon as the total light from the sun was cut off, the density of electrons fell to a very small value.

Formation of Different Electron Layers

A thermodynamical theory of ionization in the upper atmosphere by the ultraviolet rays of the sun was worked out by Prof. Pannekoek of Amsterdam in 1926, by extending Milne's modification of the Theory of Thermal Ionization first given by the present author. Chapman on the other hand, following an earlier work by Lenard worked out a mathematical theory of production of electrons by monochromatic light which as has been shown later by R. N. Rai and the author, is implicitly contained in the fuller theory of Pannekoek.

Chapman's work was insufficient in one respect, namely that it was proved only for monochromatic light whereas if we suppose the sun to be a black body at 6000°K, the ionizing radiation should consist of the whole spectrum beginning from a certain limit and extending indefinitely towards the ultraviolet. It could not be seen off-hand, if ionization by such a spectrum would not destroy much of the properties of the layer. But in the revised theory, it so happens, and it is a rather unexpected result that even continuous spectrum produces a layer very much similar to the simple one of Chapman. The form of the layer depends, to some extent on that of the photo-ionizing absorption curve which is not yet known for the ionization processes actually occurring in the atmosphere but is only deduced from a plausible theory. These various considerations lead us to the conclusion that the different stable layers as observed in the ionosphere are due to ionization, by the appropriate solar radiation, of distinct constituents of the atmosphere, *viz.*, N_2, O_2, N, O; the maximum of the layer occurring at the height where total absorption of ionizing radiation by the particles reaches its maximum value.

The E_1-layer must be due to a process of ionization which is effective only at a height of 100 km. As the amount of O_2 and N_2 above this height is of the order of a few cm. the radiation which causes E-layer ionization should be such that it can be transmitted through a few cm. of N_2 and O_2 gas at N. T. P. These considerations prove that the E layer is probably formed by the first process of ionization of O_2 and N_2 at 12.2 and 15.5 volts. The F_2-layer on the other hand, should be due to ionization by radiation which can be stopped by about 10^{-3} mm. of the gas, because at a height of 200-250 km., where this layer is formed, the amount of the gas lying above cannot exceed this amount. We can easily link up this fact with the second ionization of N_2 and O_2 which gives rise to excited O_2 and N_2, because the ionization occurs with an intensity which is about 1,000 times stronger than the first ionization. The calculated pressure is of the order of 10^{-6} to 10^{-5} mm. which is of the order of pressure at the F-layer. The F_1-layer is a purely daylight phenomenon. It is found that the night F-layer split up into F_1 and F_2 when the sun is sufficiently high up in the sky and towards nightfall, when the sun's

altitude has fallen, F_1 and F_2 unite to for one, single layer. The F_1-layer is probably due to an extra process besides ionization, which is operative only during day time. During day time the oxygen molecules probably completely dissociates into atoms at a height of about 200 km. on account of absorption of radiation between 1750Å and 1300Å. The electrons which give rise to the F_1-layer must be due to further ionization of the ozygen atoms, produced during daytime. At night or when the sun is sufficiently slanting, probably most of the ozygen atoms at this level would re combine to form molecules and therefore F_1 layer will disappear, as there are not sufficient oxygen atoms to be ionized.

Thus E_1 and F_1 layers are controlled completely by the sun but the F_2-layer behaves anomalously. During the time of total eclipses, the F_2-region ionization appears to remain unaffected. This and other facts show that either the solar control theory is insufficient for this region or that while working out the theory of photo-ionization we should not regard the system to be a unicomponent one. Probably in the F_2-region the pressure is so low that collision between electrons and ions must be extremely infrequent, and neutralization takes place after intervals of the same order of magnitude as the day and hence the equilibrium theory has probably to be considerably modified.

It must not be supposed that the theory of solar control can explain all the characteristics of the ionosphere except the F_2-region. Rather puzzling is the persistence of ionization in the E-region at night. The E-region should entirely disappear as soon as sunlight is withdrawn, because in this region collision frequency is quite large (10^7/sec.), and recombination must be very quick but we find that there is a residual ionization about 1/20th the maximum amount, which is present throughout night. It does not appear probable that this is due to positive ions. We must therefore suppose, as Martyn and Pulley have done, that at night, there is probably some mechanism at work by which fresh electrons are produced. It is not improbable that a neutral molecule colliding with a negative ion might knock out the electron and supply the electrons forming the residual E-layer at night.

A complete theory of the various puzzling ionospheric phenomena will probably take years of work. Much depends on the correct interpretation of the results obtained by the methods of reflection of radio waves from the ionosphere. It need not be supposed that the magnetoionic theory of propagation of electro-magnetic waves which is now holding the field is infallible.

Radio Fadeouts

It has been observed for some years that radio signals, which were being received from a distant station, sometimes suddenly stop and the normal conditions are obtained after lapse of time which extends usually over a few minutes. Observations showed that many of these sudden fadeouts were simultaneous with the appearance on the surface of the sun of small bright patches of intense white light. From the international programme carried out by Dellinger and Jauast, it was found that the phenomenon is confined only over the sunlit part of the globe and that it starts simultaneously at all (sunlit) stations. The radio fadeout was connected with intense chromospheric eruptions, though all eruptions did not give rise to radio fadeouts. Further investigations showed that neither the ionization nor height of the E and F layers were very much disturbed during these sudden radio fadeouts. The cause of the disturbance must, therefore, be sought below the E-region or in an intense transitory ionization of the regions below E which is sometimes called D by Appleton. This is further confirmed by increase in intensity of long-distance radio by means of very long waves during radio-fadeouts, which refer only to short and medium waves, because long waves are reflected from the low *i.e.* D-layer. Further, radio fadeouts are accompanied by magnetic disturbances of short duration, which are strongest over the part of the globe directly under the sun at the time of eruption. This shows that the small patches send out a flare of ultra-violet light which produces intense ionization of the D region.

The above short review shows that though it is easy to say that the atmosphere, the upper as well as the lower, is entirely controlled by the sun, it is very difficult to work out the details and present a complete unified theory. For this purpose, we

must know more about the normal behaviour of the sun, as well as of its abnormal behaviour which manifest in the form of spots, prominences, faculae, and the small patches of intense light responsible for radio fadeouts etc. All the astrophysical theories of the sun, giving a quantitative idea of the formation of Fraunhofer lines are somewhat unsatisfactory. There is no reason to suppose that the emission from the sun in all wavelengths should be black body radiation at a temperature of 6000°K. Moreover the common notion that the sun radiates like a black body appears to be wide of the mark, particularly in the ultraviolet region. Many difficulties would be solved if a spectrum of the sun could be secured at a height of 40-50 km., *i.e.* considerably above the ozone layer.

Vocational Guidance

Krishna Chandra Mookerjee

THE purpose of vocational psychology is to discover and measure those varying qualities of human mind that make different persons suited to different avocations. Vocational psychology has two branches and pursues a double aim. It tries to find out the best man for a given occupation as well as the best occupation for a given man. Vocational guidance consists in advising persons, after a careful examination of their aptitudes, abilities, interests, and temperamental characteristics, on their probable future vocations. The final advice rests on a basis of a gradual process of elimination, and the final selection is reached through three or four distinguishable stages.

A vocation has several important aspects, such as, economic, social, hygienic, etc. Since it is the intention in this paper to deal particularly with the specific difficulties in connexion with vocational guidance, these different aspects of the problem will not be considered in all their details. Suffice it to say that every choice of vocation must be critically examined from all these standpoints as far as possible. It is a well-known fact that a vocational misfit is not only a loss to his employer and to the society at large but a charge to himself even. In spite of all these facts, it is strange that the problem of choice of careers has not uptil now received the consideration that it deserves. In India it is almost neglected. The acuteness of the nature of unemployment in India is, however, gradually forcing the problem of vocational guidance to the attention of the public. Legislatures, universities, public bodies and leaders of societies have all begun to consider seriously about the utility of a scientific selection of careers and psychological training of boys and girls for particular professions. It may be hoped that very soon beginnings will be made at various centres and that each province will have a separate vocational advising centre, working to meet the needs and conditions of the province itself. But before any successful and thoroughly scientific method is evolved, the workers of this country as a whole and of Bengal in particular will have to overcome certain inevitable difficulties.

At the beginning let it be mentioned that there are certain difficulties which are inherent in the very nature of the problem. Such work requires sympathy and active co-operation of the public at large. In order to make any vocational guidance scheme successful here what is urgently needed is a thorough change of outlook of the public mind. The second inherent difficulty is with regard to gaining inside knowledge of an occupation. A man may possess sufficient working knowledge in a

particular occupation—he may have a thorough knowledge of its peculiarities—he may know the kind of specialized skill and abilities required—yet he may not be in a position to have the 'inside' knowledge which is something different from those just mentioned. This is a very important difficulty and unless it can be adequately solved our attempts to devise various vocational tests will not be successful to any appreciable extent. Lastly there is another inherent difficulty which is even greater in magnitude than those mentioned. It is in connection with the measurement of different temperamental traits. In practice it has been found very difficult to assess these traits. There is no dearth of tests in this field but unfortunately most of them lack in reliability and thoroughness and hence cannot be used with advantage. It can be said with some justification that there is as yet almost no satisfactory test for measuring temperament. There are of course some which can be used for ordinary and preliminary purposes with some degree of accuracy but they require to be supplemented by something more in order to be used for diagnostic purposes. One such test which is known as 'perseveration' test, has been found to be of considerable value in this field and is consequently included very often in the list of tests for the vocational guidance examination but the results are considered to be suggsetive rather than diagnostic.

In order to solve the difficulty in any satisfactory manner the vocational counsellor for the most part should depend on the direct observation of some qualities of the candidate which manifest themselves in the candidate's reactions to some concrete test situations created for the purpose, as well as on the candidate's general bearing and manners. He should also try to draw suitable inferences from the replies to some carefully designed exploratory questions and finally he should depend on the evidences contained in the confidential reports of parents and teachers. But no infallibility should be claimed for the diagnosis of temperamental traits.

There are again difficulties that are specially due to the conditions prevailing in India. The foremost one under this category is with regard to the political situation of the country. It goes without saying that politics affects every phase of our social life—that it will influence our educational and vocational activities is apparent to all and need not be dilated here. Next to these the difficulties that are found mostly relate to the practical side of the problem. The first difficulty is the indifferent attitude of the parents and guardians. Young boys or girls when they leave school have very little interest in vocations in general. No specialized interest pattern has developed in them at this stage and as a consequence the onus of deciding their future career rests largely on their parents and guardians. But fathers and guardians in most cases miss the psychological points in the choice of vocation. They put undue importance on the economic aspect of the problem. But the psychological factors must be considered at the first instance and then the economic standpoint because whatever may be the economic considerations it will be mere folly on the part of the father to select a particular career for his son or daughter for which the boy or the girl has neither the aptitude nor the abilities. The result of this forced choice will be that he or she will ultimately be a charge to the society. This difficulty is not peculiar to India alone but it is here that it is found in a marked degree. If the father happens to possess a good factory of his own or if he has a running business of whatever kind, he naturally wants his son to take up his line unhesitatingly. He would never consider for a moment that the talents and temperaments which have made him a fairly successful man in life in a particular vocation may be totally lacking in his son. There is again the other side of the picture and there also we meet with similar unhealthy situations. There are cases where the fathers having been unsuccessful in a particular profession due to obvious reasons become heavily prejudiced against their own profession. This leads them to the other extreme of supposing that almost any other job is better than the one they have tried. Family circumstances in many cases set at rest all other considerations. The boy or girl may be required to be employed immediately and this means that the very first opportunity should be utilized before considering its suitability. In addition to all these there is the consideration of family tradition. This latter consideration sometimes actually outweigh all others however important they may be. Sometimes it so happens that a casual

remark by a friend or an acquaintance makes any other choice impossible.

In view of what has been pointed out above it can be asserted without any fear of contradiction that our selection of a job is some sort of a drifting process which in atleast 99 out of 100 cases, is done very haphazardly. But curiously enough in some cases this drifting process leads to partial success while in others the result becomes entirely discouraging. The way out of these difficulties is to educate the general public and to hold the facts and figures concerning vocational misfits in different spheres before them. The second difficulty is in connection with the age at which vocational guidance should be given. The general convention is to give advice at as early an age as possible. This convention is based on the simple fact that if a person has already spent a considerable period of his life in a particular vocation, then it will be difficult as well as futile to advise him any change, for this will mean an additional number of years to be spent in the newly advised vocation by way of training. Hence in order to get rid of such wastage of time and energy, the advising work should be undertaken at an early age. But this early age should not be taken to mean a very early age; that will not serve our purpose, because it has been found that certain abilities take longer age to develop to any appreciable extent. In case of these abilities it will be difficult to detect their presence at such an early age by means of suitable tests and prescribe the proper careers.

Thus with regard to the age problem the question is what should be this early age. The present tendency is to give advice twice, at two different age levels, once at an age earlier than 15 or 16 years and the other at the school leaving time. The nature of the former advice is different from that given finally at the school leaving time. The purpose of this two-fold advice is simply to increase the reliability of the final advice on the choice of vocation. There are certain advantages of this early advice. The student may from this time concentrate on the particular lines outlined by the advisor instead of on more general and vague studies. But it must be kept in mind that this early advice which may conveniently be given at the age of 12 or 13 is nothing more than some sort of general advice which helps to decide on the type of further education to be followed. The final advice should follow the early advice after an interval of two complete years, the early advice being given when the boys or girls reach the pre-matriculation stage. According to the present system, students are to select their additional subjects for special study at the pre matriculation class, and this selection of additional subjects is some sort of specialisation no doubt. Hence it is necessary that the early advice should be given at this time.

The next difficulty is with regard to the assessment of educational attainments. As things are we can not at present put much reliance on the evidence of school reports. Ordinary school reports furnish very little valuable information and are never exhaustive. In order that these reports may be of help to us in the matter of vocational advice, they should be supplemented by other particulars namely the boy's home and family circumstances, his interest, his favourite hobbies, his extra curricular activities etc. Fortunately, however, the school attainments can be estimated by suitable achievement tests which have been devised for the purpose and in fact there is a profusion of tests in this direction. Thus this difficulty will not be serious enough to hamper the progress of vocational psychologists of this country if only the school authorities are persuaded to enter a few items in their report forms.

The next difficulty which seems to be the greatest one that stands in the way of success of any vocational guidance movement in India is the absence here of any well-established employment bureau. The ultimate purpose for which guidance is sought cannot be fulfilled to any appreciable extent unless there are organised bodies functioning chiefly to accommodate boys and girls in respective vocations determined for them by the experts.

In western countries the part played by the headmasters and headmistresses of schools for the vocational success of the boys and girls can never be neglected. But unfortunately the contribution of headmasters and headmistresses of our country towards this very important task is practically nothing at present. Then again there is the arrangement in London of careers masters and mistresses. These careers masters are experienced

psychologists. Their duty is to observe the pupils of the school to which they belong. Thus they can give many information regarding any boy which are significant for the purpose of vocational guidance. The validity of the reports given by these careers masters is greatly enchanced by the fact that they are specially trained psychologists. Unfortunately in Indian schools there are no such posts of careers masters.

In any newly opened vocational centre their want will be keenly felt by the workers. But if the work be begun in right earnest then it may be reasonably expected that the authorities concerned will not hesitate to make proper provisions for providing careers masters in different schools. With regard to the employment bureau, its necessity in the field of vocational guidance cannot be questioned. But the kind of employment bureau that we require here should be different from that of other countries. Our employment bureau should have two divisions. One will be responsible for accommodating our school boys and girls to whom different advice have been given on their choice of future vocations. It will particularly see that the boys and girls, who have been adviced, do not find and difficulty in working out the instructions. It shall also watch with interest the progress made by different boys and girls in their newly entered vocations and should there be any case of misfit, he or she should be taken care of immediately. The other division will be concerned with the final appointment of these boys and girls who are receiving specialized training. This division will be in immediate correspondence with the puble employment offices. It will maintain a register of vacancies in different centres and it should be the duty of all concerned to see that appointments in various offices, factories etc., are made as far as possible through this bureau.

However, a note of warning should be sounded to the workers in this field regarding the adoption of different foreign tests for vocational guidance work here. There is certainly no reason to deprecate these tests, many of them have gained international acceptance. But the conditions prevailing here are in some respects fundamentally different from those in other countries. Hence arises the necessity of certain modifications of these tests so that they may be suited to our local conditions and requirements. Our norms calculated whether on age or on grade basis will be somewhat different from theirs. At the beginning of any vocational guidance adventure such standardized foreign tests are of immense value, but great care should be taken in handling them and making them suitable for our local conditions.

Modern Practice in High Voltage Measurements*

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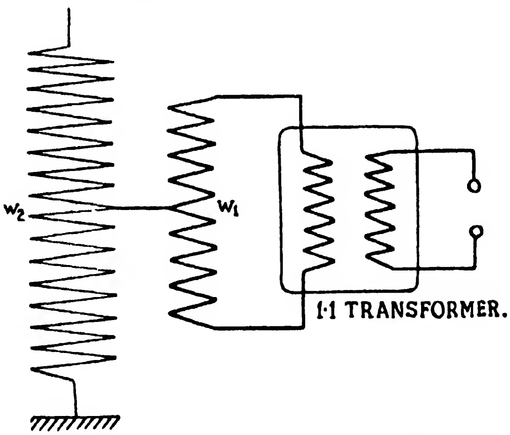
General Equipments

THE primary equipment for high voltage technique must consist of suitable generators for power-frequency tests. For power transmission purposes transformers have been built up to 350 kV; but the equipment for testing would certainly require greater voltage and in many cases need of transformers yielding 1,000 kV. (one million volts) has been felt. These voltages cannot be economically produced in a single transformer and F. Dessauer discovered a method of producing such extremely high voltages. His arrangement is shown in the following diagram.



PRINCIPLE OF DESSAUER CONNECTION.
Fig. 1.

Here the centre of the high tension winding is connected with the midpoint of the winding of the low tension transformer. One end of the high tension winding is connected with earth. This arrangement reduces the voltage gradient between the windings as well as between windings and the cores of the individual transformers. Hence, it is only necessary to provide for insulation, sufficient to withstand 250 kV., when one would require 500 kV. at the open terminal and earth.

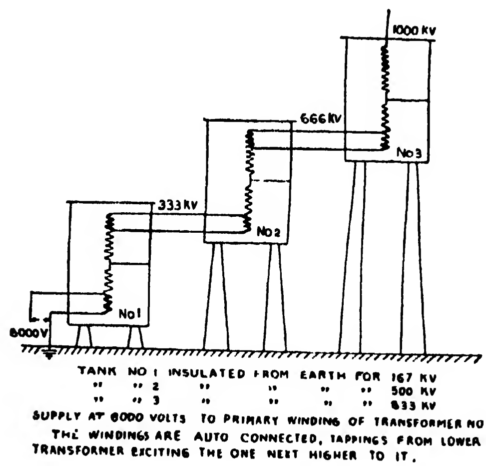
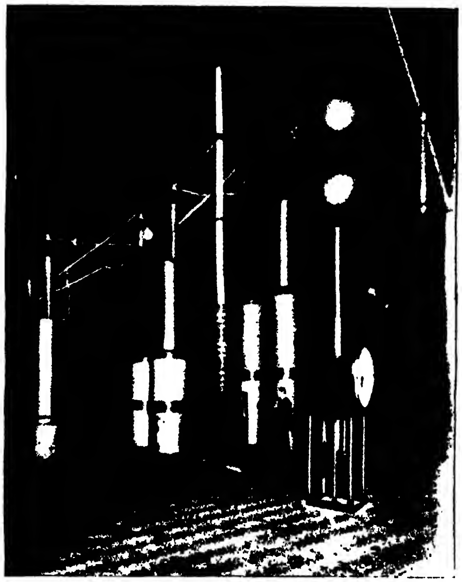


Fig. 2.

An improvement of the original Dessauer model due to Peterson and others is now used (Fig. 2). Here each successive unit as a whole is arranged for progressively higher insulation to earth. The primary winding of only the first transformer is connected with the power supply. A tapping is brought out from the insulated end of the H.T. winding, such that the voltage between this tapping point and the high voltage end of the transformer No. 1 is that required for the low tension winding of transformer No. 2. The mid-points of each wind-

* An introductory portion of this article, describing developments in power generation and transmission, appeared in our issue of November, 1938, Vol. IV No. 5.

ing are connected to the tanks which are insulated from earth by having them supported on massive bakelite cylinders. Thus the action of each tra



Cascade connected million-volt transformer with measuring sphere-gap.

former commences at the point where the previous one leaves off, and a pressure, say, of million volts to ground can be obtained from three similar transformers each of 333 kV. The H.T. winding of the last transformer will have a potential of a million volts to ground, although the bushings and the winding insulation in any one transformer are only subjected to a potential difference of 167 kV.

Equipments for Surge Tests

In addition to normal stresses on electrical apparatus, serious over-voltages may be set up due to lightning or other disturbances. In general, they are unidirectional. Although their duration is extremely short, say, a thousandth or even millionth of a second, the maximum voltage may be as high as eight times the normal working voltage. Hence failure of insulation may result. It is, therefore, desirable to test transformers, line insulators and other pieces of apparatus that are likely to be exposed to voltage surges by applying impulses to them.

The experimental investigation of the effects of transient disturbances has been rendered possible by the development of an artificial lightning generator, (Surge Generator) by Dr Marx of Brunswick. The method adopted consists in charging up a number of condensers to the same voltage in parallel through high ohmic resistances and connecting them automatically in series through spark gaps. The resistance and capacity of the circuit are adjusted so that the discharge is aperiodic and of the desired shape. Fig. 3 shows the circuit diagram of one such arrangement for the purpose of obtaining an impulsive voltage equal to four times the voltage of the supply. The operation of this circuit is easily understood, since the resistance being very high acts practically as open circuit gaps have broken down.

In theory, any number of stages could be used but the limit is reached from the consideration that a large number of stages does not allow all the condensers to be fully charged, on account of the

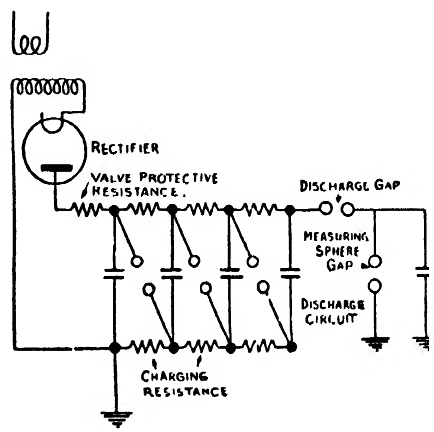


Fig. 3.

high resistances between them and the D.C. supply. The value of the available voltage is also influenced by the large number of gaps in series.

The spark gaps are all adjustable. High damping and discharge resistances are arranged in the

surge circuit in order to give the impulse wave the desired shape as regards equivalent building-up time and half crest duration—the impulse wave being

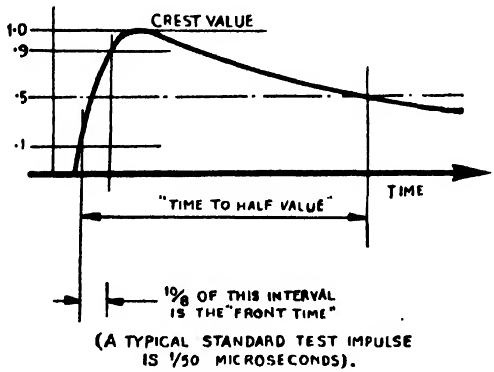


Fig. 4.

defined as one in which the crest of the wave is attained in a certain time in μsec. to the time from zero to half crest value on tail of the wave. A typical 1/50 μsec. impulse voltage is as shown above. essential as in this test, only the effect of the H.F. discharge on the insulator under test is observed.

For producing damped high frequency oscillations a Tesla transformer together with a circuit containing a quenched spark gap is used. The diagram of connection is as shown in the Fig. 5.

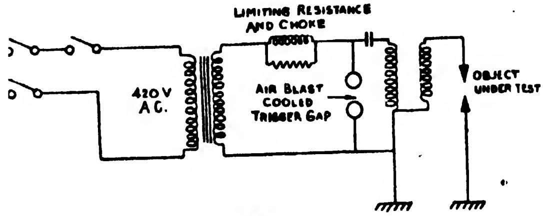
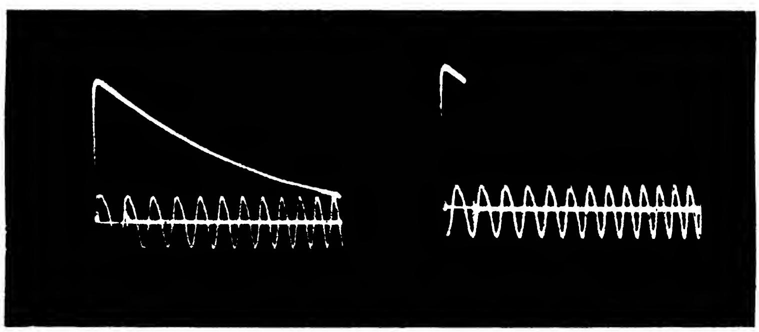


Fig. 5.

The condenser in the primary circuit is charged up from an A.C. or D.C. source until the trigger gap sparks over. The primary circuit is then closed and the discharge from the primary condenser then oscillates with a certain frequency, which causes an oscillatory voltage to be built up across the secondary, the energy initially stored in the primary being thus transferred to the secondary winding. The reverse process then takes place so that as the energy is restored to the primary winding, the oscillations



Negative 1/50 point plane breakdown 8 μ Sec/cycle.

High Frequency Tests (Tesla Transformer)

Very high frequency combined with high voltage are generally used for the detection of inhomogeneity in insulation such as air voids in composite insulators, compound filled porcelain bushes, etc. For such test the testing frequency should be, say, above 100,000 periods per second. The measurement of H.F. pressure in volts is not, however, in the secondary diminish and those in the primary increase. But if the arc across the trigger gap be interrupted by an air blast just when the amplitude of the primary voltage oscillation is approaching zero, the transference of the energy back to the primary can be prevented. Waves produced by such process is depicted in Fig. 6.

The frequency of oscillation is given by the

natural frequency of oscillation of the primary, the frequency of the secondary being, of course, the same as the primary and the secondary are con-

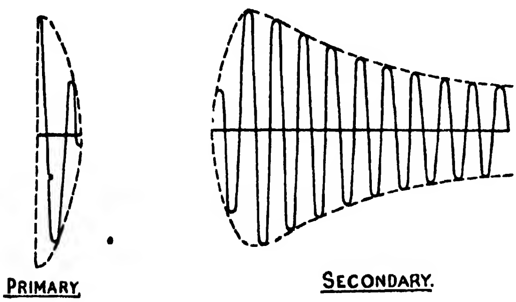


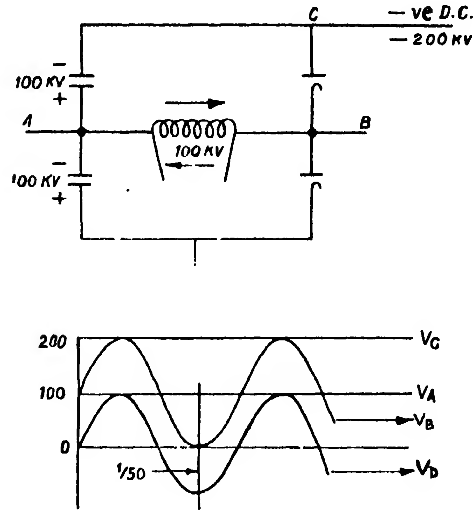
Fig. 6.

structed to be in tune, or nearly so. An apparatus had been developed in the Palace of Light of the Exhibition of Arts and Technics in France in 1937, where the high frequency coils were mounted upon a frame work of fused quartz insulation and the wave length of oscillations were of the order of 550 metres.

High Voltage D. C. Generator

For testing of extra high-tension apparatus, whose electrostatic capacity is high and also for testing cables laid in ground, direct current is used. High voltage D.C. is also used for the supply of unidirectional impulse to X-ray tubes, and within recent times, in physical research laboratory for research on nuclear physics. This is most readily obtained from a high voltage transformer, the current being rectified by the use of the thermionic rectifier. A single wave rectification may be quite sufficient for moderate loads but full wave rectification on a single or three-phase supply is most satisfactory for large loads.

For voltage in excess of 100 kV., some form of voltage multiplier circuit is required. Greinacher's voltage doubling circuit is shown in the Fig. 7 by which full wave rectification is obtained by means of two thermionic valves. In the electrostatic belt generator due to Dr Van de Graaf and in the cyclotron due to Dr Lawrence of California U. S. A., D. C. voltage of the order of several million



GREINACHAR VOLTAGE DOUBLING CIRCUIT.

Fig. 7.

volts have been produced and they are being used in some of the physical laboratories of the world for getting high-speed charged particles with which nuclei are being bombarded, but they have not yet been used for technical purposes.

Dr Cockroft invented the multiplier circuit by which any multiple of the supply high-voltage can be obtained. Fig. 8 shows this circuit in which the arrangement is shown for obtaining a voltage up to four times the peak output voltage of the transformer. The generator comprises four rectifying valves R_1 –R_4, four condensers C_1–C_4 and a transformer T, fed from an alteranating current source.

The H. T. winding of the transformer giving a potential E is connected in series with a condenser across the Diode R_1. Then power will be delivered from the transformer and the condenser C_1 is charged through diode R_1 to potential $-E$ at the positive peak of the transformer wave. The potential of the point A, therefore, alternates between zero and $-2E$ as the potential at the H. T. end of the transformer fluctuates from $-E$ to $+E$. Now, if the circuit containing the rectifier R_2 and the condenser C_2 is

examined, it will be seen when 'A' approaches a potential below that at 'B,' condenser C_2 is charged through diode R_2 instead of condenser C_1, receiving power from a D. C. source as in the previous circuit. As the potential of 'A' rises again, the condenser C_3 is charged through diode R_3 to a potential difference of $2E$ which is the highest potential attained

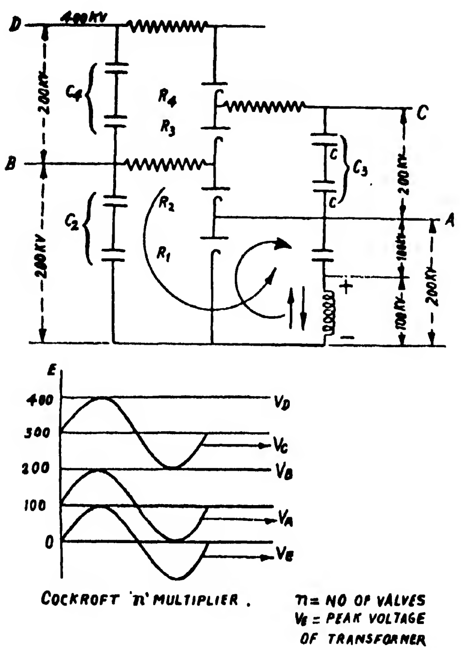
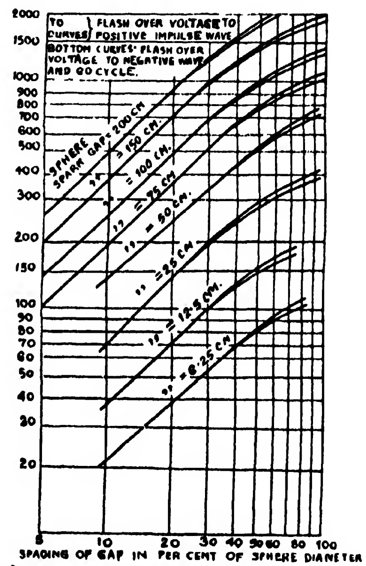


Fig. 8.

by the point B, the rectifying action of R_2 preventing the condenser C_2 to discharge back into C_1. When C_3 is fully charged to this value, the potential at the point C varies from $-2E$ to $-4E$ as the potential at A varies from 0 to $-2E$. Consequently the condenser C_4 is charged up to a voltage of $-2E$ An equilibrium state is reached when each of condensers C_1 to C_4 is charged approximately to voltage $-2E$ when the potential at the point D reaches a steady value of $-4E$. A positive direct voltage may be obtained from the generator by reversing the rectifying valves.

Measurements and its Equipments

The measurement of A. C. voltage is an important feature of H.V. engineering. Electrostatic voltmeters were first used by Lord Kelvin in the early eighties and the types, that are commercially available now, can reach up to 100 kV., though in the higher voltage region the indications are not very reliable due to edge influences. This has led to the adoption of sphere gap voltmeter formed with two equal spheres as electrodes at gap lengths up to twice the sphere radius, the dielectric being air and calibration curves (Fig. 9) are available for many sizes of spheres up to 2 metres in diameter and 1000 kV. (effective).



SPARKOVER VOLTAGE OF SPHERE GAPS OF 6·25 TO 200 CM. DIAMETER. ONE SPHERE EARTHED. RELATIVE AIR DENSITY = 1·00.

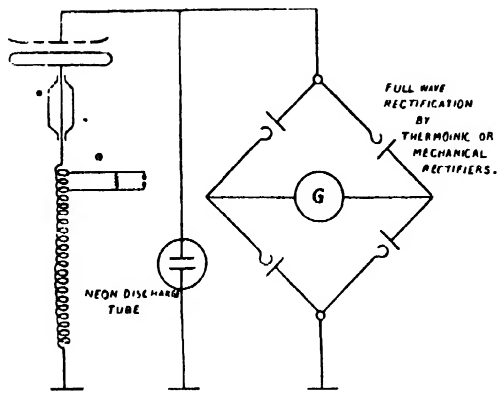
Fig. 9.

But the most widely used precision voltmeter is the crest voltmeter, the principle underlying which is as follows.

In this method the secondary voltage is applied to a high voltage condenser of high impedance. (Fig. 10) The capacity current passing through the condenser depends upon the maximum value of the voltage applied to it and upon the frequency of that

MODERN PRACTICE IN THE HIGH VOLTAGE MEASUREMENTS

voltage. By rectifying the current passing through the condenser by means of suitable valves or by a mechanical rectifier, it is possible to obtain at a given frequency a direct reading of the voltage on a sensitive direct current galvanometer or a milliammeter. The direct current is thus a true measure of



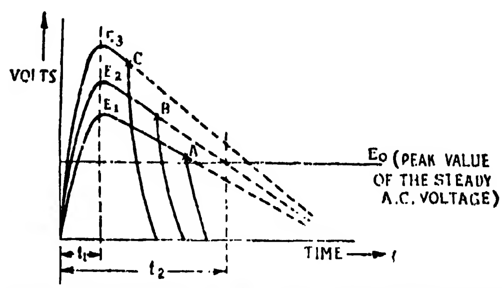
CREST VOLTMETER

Fig. 10.

the peak voltage irrespective of the wave form. This method can be considered to give an absolute measurement of the high voltage with an accuracy dependent upon the precision with which the capacitance of the high voltage condenser is known.. This system of voltage measurement is independent of atmospheric conditions.

Measurement of impulse voltage is usually made with a sphere gap. The calibration curve at power frequency is used for such measurement but care is necessary to obtain reliable results. A satisfactory method is to reduce the spark gap setting until a discharge takes place with successive application of impulses, either over the insulator under test or over the sphere gap under this condition, the number of such discharges being equally divided between the two. The sphere gap setting is then used to obtain the applied voltage from the calibration curve at power frequencies. The assumption underlying this is that the spark gaps are characterized by an impulse ratio equal to unity, where impulse ratio is defined as ratio of the peak value of impulse volts to cause flash-over and the peak value of power frequency flash-over volts. The necessity to refer to peak volts in this comparison is of course due to wave shape and the fact that breakdown depends on the maximum gradient.

A dielectric will sustain continuously its insulating properties up to a certain critical voltage E_0. For higher voltages above this, breakdown is inevitable but a certain finite interval of time will be required to complete the process, and this interval will be shorter the greater the applied voltage. (Fig. 11). There is thus a definite relationship between the voltage producing the breakdown and the time necessary for the completion of the process. This time lag, depending as it does on the shape of the electrodes, is shorter for spheres which produce approximately uniform fields and longer for needles which give rise to concentration of potential gradient. The polarity also influences the impulse ratio, which is lower when the higher potential gradient electrode is positive.



Relation between the magnitude of a voltage impulse and the time required to produce breakdown of an insulator.

Fig. 11.

In spite of the early recognition of the sphere gap as a practical standard, its limitations were not fully realised. For example, errors have resulted from extrapolating the empirical formulae derived from the original fundamental calibrations of small sphere spark gaps and applying these calculated calibration indiscriminately to measure both industrial frequency voltage and impulse voltage. In recent years many of the factors affecting sphere gap results have been fairly investigated. Davies and Bolder in a recent paper before the Institution of Electrical Engineers has given the result of an independent set of calibration for a sphere gap obtained at the N. P. L., the object being the formulation

MODERN PRACTICE IN THE HIGH VOLTAGE MEASUREMENTS

of impulse flash over figures. High voltage cathode-ray oscillograph and resistance voltage-divider was used to determine the characteristics of the gap between spheres ranging in diameter from 125 mm. to 1000 mm. They found contrary to the experiences of other workers that the power frequency flash over values are always less than the corresponding negative impulse figures. At a spacing equal to the radius of the sphere the difference has been found to be approximately 5%. Further, the extremes of wave shape do not affect the minimum impulse flash over voltage but when breakdown occurs in the front of the wave the spark gaps are not suitable for the measurement of the voltage.

Edwards and Smee has dealt with the calibration of sphere gap upto 200 cm. in diameter for measurement of voltage up to 1 million volts (effective) at 50 cycles. They based their calibration on the use of a crest voltmeter in which a precision measurement o. the capacitance of the associated air condenser has been taken advantage of.

From the results it appears that B. S. I. figures of 1929 are about 2% higher than those proposed by American Institute of Electrical Engineering standard of 1936 except for the largest size of spheres, while the calibrations from their results are about 2% lower than these standards except for 12.5 cm. A special device was employed for determining the polarity effect with the help of thyratron valves. Investigations also showed that calibration of spark gaps at small spacing may be seriously in error unless some means are adopted for pre-ionizing the air of the spark gap by the use of radium, ultra-violet rays or other irradiating source.

The recent development of the high speed cathode ray oscillograph is mainly responsible for the satisfactory progress in H. V. technique. It is an essentail piece of equipment for studying ultra-rapid transient phenomena. Until very recently satisfactory conclusions regarding lightning surges and disturbances due to switching operations, etc., were difficult to draw owing to the absence of suitable recording apparatus. The satisfactory delineation of transients lasting only 1/10th micro-second has now been made possible by the development of a high speed C.R.O. whose recording membe. is the inertia-less electron beam.

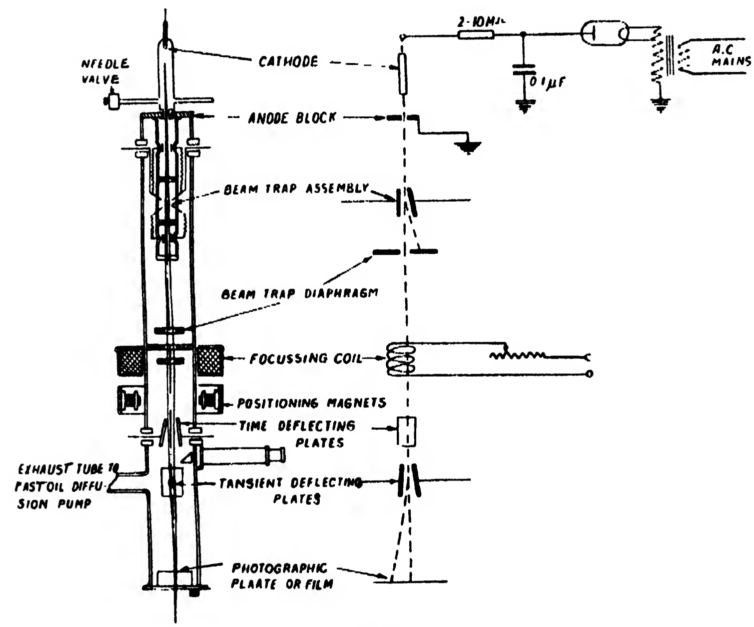
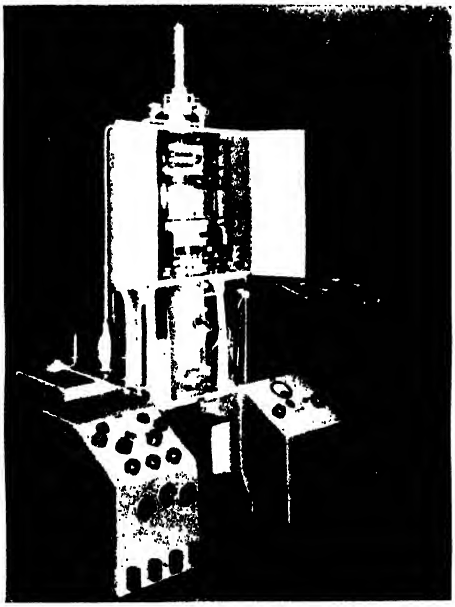


Fig. 12.

MODERN PRACTICE IN THE HIGH VOLTAGE MEASUREMENTS

This apparatus, for the purpose of description, may be divided into four sections, *viz.*, (*i*) the discharge tube (*ii*) the beam trap assembly, (*iii*) the deflection tube and (*iv*) the recording chambers. Fig. 12 is an outline sketch of a typical oscillograph



Cathode-Ray oscillograph showing the control cubicles.

of this type and the corresponding schematic diagram. At the top is the discharge between the cathode and anode. The anode is usually earthed while the cathode is maintained at a voltage of -10 to -80 kV supplied from a high tension transformer and a rectifier. The anode is pierced with a small hole. When the discharge is maintained at a pressure of about 10^{-2} mm of mercury, a stream of free electrons passes through this hole into the main tube. The main tube is constructed of a solid drawn brass tubing free from flows. By this means complete electrostatic screening is also possible. The beam enters the main tube as a slightly divergent beam and can be brought to a sharp focus at the recording section by applying a longitudinal magnetic field. For this purpose the main tube is surrounded near about its middle by a focussing coil which carries a direct current. A pressure of about 10^{-2} mm., is required in the discharge tube while the pressure in the deflection section should be maintained at 10^{-4} mm., as otherwise loss of energy and scattering would result. For this purpose the two sections are sealed vacuum-tight from one another, except for the extremely small anode hole. The whole tube is then evacuated down to about 10^{-4} mm. so that no discharge takes place even when a high potential is applied between the cathode and anode. With the potential still on, the pressure in the discharge section is then raised allowing a flow of air into the discharge tube through a suitable needle value. By maintaining continuous evacuation with a view to remove the air which might otherwise enter the main tube from the discharge section the original pressure difference is maintained.

For work on transient phenomena it is desirable that the beam should be prevented from falling on the plate except during the instant of recording. The beam trap assembly is built up on a removable head inside the upper half of the main tube so that during the inoperative periods, the electron beam can be deflected or trapped electrostatically by applying a suitable P.D. to the beam trap plates. The potential is removed when the transient arrives and the beam is automatically released for recording. It is then retrapped after the recording.

The deflection chamber contains two pairs of deflecting plates at right angles being mounted one above the other and suitably insulated from the oscillographic body. The upper pair is used to record the deflection by the voltage while the lower pair provides the time axis of the oscillogram. The time sweep plates are connected across the condenser of a condenser resistance circuit. When the condenser is discharged the beam is uniformly swept out across the recorder according to the simple exponential law. By arranging the final position of the spot to lie a long way of the film, the time scale can be made nearly linear.

The film in the recording chamber is normally covered by a fluorescent screen from which visual observation can be obtained by the viewing window with the help of a telescope and a right-angled prism. During the time of photography the lid can

be opened by turning the shaft which passes through vacuum-tight cone joint.

In taking records of a transient voltage three things should operate synchronously. These are (*i*)detrapping the ray, (*ii*) starting the time sweep and (*iii*) recording of commencement of the transient. In the high voltage impulse work the tripping impulse is picked up by a small antenna which releases the beam and excites the time sweep plates. The measurement of high voltage transients requires a potential divider for tapping off a few hundred volts for the oscillograph and a delay cable which should be long enough to retard the arrival of the impulse at the deflection plate after the sweep circuit is tripped.

The nature of the breakdown of insulating material has been engaging the attention of various investigators from a purely theoritical standpoint. Hartshorn has given a very elegant survey of the general idea of the phenomena in his recent paper on "Breakdown of Insulating Material—Electric Strength" published in the *Progress of Physics*, Vol. 4, 1937, in which in discussing the present theories he points out (*a*) that the problem of breakdown of solid insulating material is possibly due to the existence of weak spot in the material, and (*b*) that all known insulating material possess a finite electrical conductivity and therefore would dissipate a certain amount of energy as heat when placed in an electric field and the heat generated in this way may increase to a degree as to destroy the material even in the absence of weak spot stated above.

Breakdown of this nature is very common with alternating voltages especially of H.F. and is closely connected with the problem of dielectric loss. When breakdown occurs due to thermal instability, the determination of the dielectric strength is of doubtful utility and the study of the power factor of the material for higher and higher voltages at different frequencies is essential. The need for power factor measurement is also indicated by the fact that there are a number of organic materials which normally contain moisture and the breakdown in some of these, though appear like sudden explosive discharge show on careful examination that in the earlier stage there was a continuous loss of insulating properties. The present conception, therefore, necessitates the evaluation of the power loss in a dielectric, not only before installation, but also, if possible, under working condition. This will give to a reasonable extent the insulating properties when subjected to continuous stress.

The general equipment which is now universally used is the type of bridge first developed by Schering in which the combination of resistances and capacitances in the arms of the bridge, combined with a standard no-loss condenser, enables one to ascertain the power factor of the insulating material. The Schering bridge circuit in its simplest form is shown in Fig. 13. By this method the capacitance

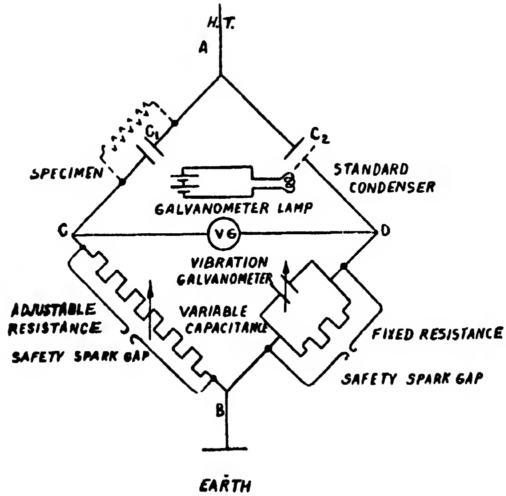


Fig. 13.

and power factor of the sample C_1 are determined by comparison with an air condenser C_2 of no loss. They are inserted in the two bridge branches in the H.V. side, while one of the arms on the low voltage side contains a variable capacitance in parallel with a fixed known resistance. The other arm contains a variable non-inductive resistance. The galvanometer connected between the points C and D will show no deflection when the potentials at these points are in phase and equal in magnitude. The scales of the dials of the bridge can be calibrated directly and power factor and capacitance can be found out. From the measured values of capa-

citance and power factor the permittivity and the loss in the dielectric can be determined.

100 kV. Schering Bridge showing the ratio arms, transformer, control desk and compressed air condenser in the back ground.

The sensitivity of a bridge-measuring circuit was worked out by Lord Rayleigh (1891). For maximum sensitivity of the bridge the impedance of the arms of the bridge as well as those of the source and detector should be the same. This condition is disregarded in the Schering bridge circuit. From the point of view of high voltage testing it is this independence which gives the Schering bridge circuit a marked advantage over other bridge circuit arrangements. The impedances of the arms R_3 and C_4 R_4 are only of the order of one hundred thousandth of the impedances of the arms containing C_1 and C_2, so that all the apparatus excepting C_1 and C_2 is within a fraction of 1 volt of earth potential, even when test voltages of the order of 50 kV., are used. Moreover there is no need to have any access to any of the high voltage parts of the bridge during test. To overcome the theoretical lack of sensitivity, with the impedances of the arms so different, the bridge relies upon the use of a very sensitive detector for the accuracy and sensitivity of the measurement.

Conclusions

It may be observed that the stability of insulating properties of the material is a very important factor in the maintenance of the high voltage equipments both regarding transmission and use, and a more thorough and systematic measurement would be useful to ascertain the various causes which lead to the breakdown of insulators. With the advent of different types of artificial resins and their uses as insulating material for different purposes, dielectric measurement is, naturally, of great consequence from this point of view. Materials of low loss and high dielectric strength and of stable properties are really required by power engineers to maintain security of supply. Investigations relating to these factors form a very essential element in the present state of electrical engineering. It is now known that the different nations of the world have been applying themselves to the study of these important properties. If India is to fast develop her electrical power a large network of power lines will have to develop in this country. Considering the varied climatic conditions of India *viz.*, high humidity combined with high temperature in many of the provinces of this vast country, one can easily realise that India has to take up these investigations for her own need. Unfortunately, there has been no attempt uptil now in any quarter to initiate high voltage measurements in its different aspects. The early establishment of a suitable High Voltage Laboratory cannot be too strongly urged due to the above mentioned considerations. The manufacture of high grade porcelain suitable for insulators has recently been started here and it is no wonder that there have been no data available at the present moment about the behaviour of them under the conditions prevailing in this country and it is high time that high voltage investigations should be taken up. These will immediately lead to the growth of the ceramic industry and will supply data to other manufacturers interlocked with industrial planning for India.

NOTES AND NEWS

OBITUARY

GEORGES URBAIN.

Georges Urbain, who may be rightly called the master of the chemistry of rare earths, died on November 5 last, after a short illness, in the fulness of his powers of production. His contributions to science as a chemist has given him a place in the foremost rank of scientists of all times.

Georges Urbain was born in Paris on April 12, 1872. Son of a tutor in the *Ecole Centrale des Arts et Manufacture*, he imbibed from his father a great liking for chemistry. After a successful scholastic career in the *Ecole Lavoisier* he was admitted into the *Ecole de Physique et de Chemie Industrielles* in Paris and studied there during the period 1890-1894. Soon after he directed his attention to scientific research. He had all the qualifications of a true research worker and a perfect experimenter—powerful originality, minute observation, systematic methods and above all a critical mind, such as few men have equalled. Great were the honours bestowed upon him. He served as Professor of Chemistry in Sorbonne and was elected a member of the *Academie des Sciences* in 1921. He was also elected President of the International Commission of Atomic Weights and held the honourable office of the Director of the Institute of Chemistry of Paris.

Even though scientific research was the motto of his life, he engaged himself on several occasions in various extra-academic activities. He wrote several treatises of which the one entitled *Les Disciplines d'une science, la Chemie* has gained greatest popularity. During the last Great War he focussed his attention towards problems connected with national defence and rendered valuable services to his motherland. He agreed to edit the voluminous encyclopaedia entitled *La Science, sa Progres et ses Applications;* he also took the charge of of organising the chemistry section of the *Palais de la Decouverte* which was founded by courtesy of the great Exhibition held in France in 1937.

When Georges Urbain entered into the field of his researches, there was considerable confusion in the domain of mineral chemistry. His systematic and continued researches and his precise experimental methods enabled him to reduce the overwhelming complexity to law and order which were in brilliant confirmation of the periodic classification of elements proposed by Mendeléeff. All precise determinations of the atomic weights of the so-called rare earths were the work of Georges Urbain. The element "lutecium" which occupies the 71st place in the periodic table was discovered by him in 1907. Later on he characterised the element 72 which he called "Celtium" and which in fact, is not a member of the family of rare earths. Truly a friend of Georges Urban has said of him—"The work of Georges Urban evinces powerful originality; it is that of a true research worker and a great thinker; he worked with the independence of a creative genius." The world of science is poorer today by the death of Urbain.

HOWARD CARTER

A message from London announces the death of Mr Howard Carter, the famous Egyptologist and discoverer of the tomb of King Tutankhamen.

Howard Carter was born at Swaffham, Norfolk, in 1873 and owing to weak health was educated privately. At 17 he obtained a post on the staff of the Egypt Exploration Fund and was sent to Egypt to take part in an archæological survey. Two years later he was one of Prof. Flinders Petrie's assistants in the excavation of Tel-el-Amara and then for six years was a

draughtsman in connexion with a great survey undertaken by the Fund.

By that time his studies and experience ranked him with the experts and the Egyptian Government appointed him Inspector General of its Antiquities Department. One of the important schemes which had to be carried out in the next few years was the exploration of the region which was to be submerged in 1912 when the great Assuan Dam was raised, and the preservation of the antiquities lying there. Carter on behalf of the Egyptian Government also started a scientific investigation of the Valley of the Kings and made discoveries in the royal tombs there, which threw new light on various periods of the history of ancient Egypt. The culminating point of this big undertaking was reached in 1921 when at the expense and with the aid of the Earl of Carnarvon he found and opened the wonderful underground tomb of Tutankhamen.

The enormous store of golden, jewelled and other treasures discovered in the sepulchre, were really priceless. The discovery made one of the greatest archaeological sensations ever known.

Soon afterwards Lord Carnarvon died and in the next year or two the deaths of other persons associated with the discovery occurred. These coincidences led to the circulation of the legend that there was a curse attached to the tomb and that all who disturbed its contents would come to an untimely end. Carter however declared the story to be nonsense.

Carter wrote a number of valuable books and reports on his discoveries in Egypt.

State Aid for Scientific Research in Great Britain

The November-December number of the *Scientific Worker* has published a memorandum prepared by the Association of Scientific Workers in collaboration with the Parliamentary Science Committee on the important question of financing and organization of research in Great Britain. The most important point pressed in the memorandum is that scientific research should be provided with a regular and increasing income. At present a fluctuating amount of money is available for research and there is a lack of provision for steady development of scientific research in industry. This adversely affects the personnel and conditions of employment of the scientific staff. The research worker has almost no standing and a very insecure livelihood. In most firms he is not adequately paid as compared with the executive branch. The ultimate sources of money needed for research are the Government and industry, and the memorandum argues that the Government contribution to research institutions and to research associations should take the form of block grants for period of five to ten years in advance and that the Department of Scientific and Industrial Research, along with the Medical and Agricultural Research Councils should obtain a corresponding guarantee of industrial contributions for a corresponding period and that negotiations should be undertaken by the Department with industries for which research facilities are at present inadequate with the view of providing a comprehensive system of Government aided industrial research. Recommendations have been made for the establishment of National Scientific Research Endowment Fund, to which the Exchequer would pay an annual sum of £3,000,000. The Department of Scientific and Industrial Research should endeavour to secure from industry and agriculture contributions to the fund which over a number of years would provide an aggregate equivalent to that provided from Government funds. The control of the fund and of the payment from it has been recommended to be vested in a Scientific Research Endowment Board, an autonomous authority including representatives of Government departments, industrial agricultural and scientific and medical associations, the universities and the public. The memorandum stresses the need for rationalization of the present organization and for an attempt to bring all scientific research into one comprehensive and ordered scheme.

In spite of what the State and the industries do for scientific research in Great Britain, there is always an insistent demand for the betterment of the condition of scientific research workers, for greater aid from State and industries and for better organization and coordination of research. If we look at the state of affairs in this country, the picture seems to be much darker. If the Government and the industries in Great Britain are found in fault for not adequately providing for scientific research, what will be the position of the Government and the industries in India in relation to financing of scientific research? Except maintaining a few scientific departments the Government has paid scanty attention to promotion and organisation of

scientific and industrial research in the country. The contribution of the industries towards the same has been practically nil. The universities which have undertaken the largest share in the promotion and carrying out of scientific research in India have always had to work within the restricted scope of limited funds, absence of suitable laboratories and paucity of staff. If greater necessity for scientific research has been felt in the country, it has not, as yet, been realized that scientific research work requires considerable outlay of money and if the country is to be benefited by such work the States and the industries must come forward with a much more generous financial aid.

Faith and Religion in Science

The meeting of the American Association for the Advancement of Science, which took place at Richmond during December 27-31, was the occasion of the delivery of two addresses by two of the leaders of scientific thought in the United States and Great Britain at the present day. Prof. G. D. Birkhoff, President of the American Association and Sir Richard Gregory, Chairman of the Division for the Social and International Relation of Science of the British Association, declared their faith in the mission of Science in the solution of the different adjustments lying at the root of the difficulties and dangers facing the present-day world. Prof. Birkhoff holds that in the daring effort of the man of science to extend knowledge, their arises a spontaneous faith and it is this faith in the ultimate truth of certain fundamental principles which is the most powerful incentive to further progress and is the guiding star of the man of science. Sir Richard in his address shows that in the study of man and society from the earliest ages it is seen that faith in an unseen power is a fundamental component of human nature and in the course of the development of mankind, faith has developed not only in the conception of the object of devotion and its relation to the universe, but also in the extension of the circle of those to whom the ethical system which is its accompaniment is made to apply. Development of spiritual and ethical concepts have no doubt been retarded in comparison with material development, but Sir Richard sees hope for the ultimate approach of one to the other of religion and Science, only in the recognition of the conception of a process of continuous development in theological and ethical ideas. In the fundamental urge of faith he sees a guide pointing the way to an enlargement of the ethical ideal, in which present differences and antagonisms may be resolved.

Protection of Science and Learning

The report for 1938 of the Society for the Protection of Science and Learning, which has been recently issued, shows the large extent of active support offered in Great Britain to academic refugees from abroad.

In the words of Sir William Beveridge, the Vice President, "The Society exists to help scholars and scientists displaced from their own universities and professions to be reabsorbed into academic life elsewhere, so that their intellectual gift and training may not be wasted and so that each individual scientist, scholar and doctor may still be able to make the contribution to knowledge which in many cases he and he alone is capable of making." During the last five years financial contribution towards the fund of the organization amounted to £10,000 and individuals and committees in most of the academic centres lent ready assistance to exiled colleagues from abroad. So far the society has succeeded in placing over 500 savants permanently and nearly 350 savants temporarily, and amongst them are men and women whose intellectual gifts and genius form part of the cultural wealth of the world. The society has done much to spread information and sympathy concerning the plight and prospects of academic refugees in all British academic centres and both official and non-official distinguished personages have lent their active support in the matter. As a mark of approval and testimony to the importance of the work done by the Society the Royal Society in collaboration with the British Academy gave a special reception to academic exiles and those who have been working in their interests.

Scope of Private Enterprise in Archaeological and Anthropological Research in India

In initiating a discussion on this subject at the meeting of the section of anthropology, Indian Science Congress, Lahore, Dr C. L. Fabri pointed out that India is the only country where archæology is entirely in the hands of a Government department whereas in Egypt, Iran, Iraq, China, Greece, and Italy

most important excavations are undertaken by learned bodies or individuals, supported by private munificence. The Archaeological Survey of India has done valuable work no doubt, but the department is always overworked, particularly due to some retrenchment of the staff made during recent years, and much of the time of the officers are taken up by administrative work and conservation of the collected materials. Moreover, due to total inadequacy of financial grants, the department has not been able to undertake much important research work. Research work therefore has to be undertaken by private enterprise and the speaker suggested the establishing of private excavations and research funds, such as has been recently done in the Punjab. These organisations may hope to secure some support from the local governments though mainly depending on private aid. The Archaeological Survey would then have to play the role of a supervising institution granting licences to approved and well-equipped societies, and also seeing that the latest methods of scientific work are followed. This is what happens in most countries, like Egypt, Iran, China, Iraq, where the Government department carries out yearly not more than one excavation, but supervises the work of a large number of non-governmental bodies. In India the attitude of the government department in the matter of granting licences must change. There should not be any reluctance on the part of the Survey in granting licences and other facilities to these young provincial societies, as their work is finally meant to be for the benefit of Indian archaeology. Dr Fabri remarked incidentally that he had no reasons for complaint, as he had received sympathetic treatment from the department and the work of the Punjab Exploration Fund is going steadily on. Only more energetic forward policy is wanted, which would be all to the benefit of antiquarian research in this country.

Another advantage of private organisations undertaking the work would be the necessity of informing the large public about their work. The Government officers, who are already overworked, cannot spare their time for lecturing to the public; but officers of a private exploration fund will have to make periodical reports to their donors, and keep the enthusiasm of the public alive. They will thus indirectly help a next generation of archaeologists to be brought up. Professor Chattopadhyay and Dr D. N. Majumdar also suggested that more time should be devoted to educate public opinion and to get the people interested in archaeological research work.

A committee consisting of Lt. Col. Gordon, Prof. K. P. Chattopadhyay, Rai Bahadur Sarat Chandra Roy, Dr D. N. Majumdar (Convener), Dr C. L. Fabri (Secretary), and The President, Anthropology Section of the Indian Science Congress, 1940, was set up to draw a definite plan of how such private enterprises as suggested by Dr. Fabri can be properly organised.

Tibet's Link with India

The researches of the distinguished orientalist Prof. Ginseppe Tucci of the Italian Academy of Science, have added another important chapter to the histroy of Greater India. One of the formost authorities on Tibet, Prof. Tucci during his many visits to that country, has made discoveries leading to the belief that the histories of Tibet and India are inseparably intertwined.

His investigations have convinced him of the existence of a link between Tibetan and Indian cultures. In many monastaries in western Tibet which belongs to the 10th or 11th century, there are paintings and statues which were the works of Indian artists. Not only Tibetan Buddhism with all its literature, owes its origin to India, but also Tibetan art chiefly in its early stages was nothing but a branch of Indian art. Some frescoes discovered in a monsastery at Mangnang, belonging to the 11th century were the works of Kashmir artists and shows great similarity with the paintings found in the Ajanta and Bagh caves. Even when Tibetan art began to develop later and had acquired a character of its own, the Indian tradition was still strong enough to influence the artistic manifestations of Tibet. The Indian influence continued even when Tibet came in close contact with Chinese art. Tibetan art which deserves greater attention than it has received up to now; is a direct derivation from Indian models and a translation into visible forms of Indian ideals. A study of Tibetan art leads the students to the conclusion that Tibet was a province of that greater India which, under the impulse of Buddhism, spread its civilizing influences all over Asia. If in the matter of her art, Tibet was a pupil of India, the influence of Indian culture was no less in other spheres of Tibetan life in the past. Tibetan mystics and philosophers have handed down doctrines and experiences taught by their

Indian masters without altering their teachings in any way. There appeared to be no break in the cultural contact between Tibet and India in the past and every student of Hinduism or Buddhism is likely to be largely benefited by these researches in Tibetan culture.

Centenary of the late Mr J. N. Tata

The centenary of the birth of Mr. J. N. Tata was celebrated at Jamshedpur and in other parts of India on March 3, 1939. Jamsetji contributed more than anybody else to the industrial regeneration of India and facilitated the transition of this country from the agricultural to the industrial stage. A visionary and a realist as he was, he early realized that three factors are essential to the industrial development of the country: facilities for scientific and technical education, a well-established iron and steel industry, and a cheap supply of electric power. Being somewhat dissatisfied with the then existing system of higher education in the country he started the J. N. Tata education scheme which made it possible for poor Indian students to receive education abroad to qualify them for higher administrative and technical services. He also made a princely donation of Rs. 30 lakhs for the establishment for an institute of research in India with the express purpose of facilitating the application of science to industry. Unlike some of his co-religionists he rose above communal considerations, and though accused by them of having ingored the claims of his own community, he realized that it would be foolish to exclude others from the benefits of his schemes.

The hydro-electric project near Bombay also owed its inception to Jamsetji Tata who founded a syndicate to work out the scheme and did much preliminary work in that connection. He did not live to see the inauguration of the project, his place on the syndicate being later taken up by his son Sir Dorabji Tata. The establishment of an iron and steel industry in India was lifelong dream of Jamsetji Tata. He personally visited the iron districts of Great Britain and America and consulted experts there. Many difficulties were encountered in making his scheme move but he pursued his ideal. Though he could not see the completion of his scheme in his lifetime, after his death it was enthusiastically taken up by his able successor Sir Dorabji Tata and today in India we have one of the largest and most highly developed steel producing companies of the world.

The name of Jamsetji Tata will always be associated with the Indian Institute of Science at Bengalore, the hydro-electric power project in the Western ghats and the Iron and Steel Company at Jamshedpur and he will be gratefully remembered by his countrymen as a great industrial genius, educationist and patriot. In a special supplement to this issue of our journal we publish a life-sketch of Mr. J. N. Tata and an account of the steel industry at Jamshedpur written by its present General Manager, Mr. J. J. Ghandy.

Cattle Research in India

The value of veterinary research was stressed by His Excellency the Viceroy in his address delivered on the occassion of the opening of Animal Nutrition Wing of the Imperial Veterinary Research Institute at Izatnagar. India holds a substantial proportion of the domestic animals of the world, over one-fourth of the world's stocks of cattle and two-thirds of its buffaloes. In addition, she sustains something like 97 million sheep and goats. The aggregate of domestic animals is larger than that required in a properly balanced economy and imposes a too heavy demand in terms of fodder and feeding stuffs.

The prevalence of animal disease in India is the main clue to the enormous stock of animals which India houses. Very heavy losses are suffered from contagious diseases, such as rinderpest, anthrax, surra, and the like and these losses have often menaced the actual carrying out of agricultural operations. In India the bullock being practically the only source of tractive power, epidemics of animal disease deprive the cultivator both of the value of his working bullocks and of a large part of his crop. So long as disease reigns uncontrolled, the cultivator tends to carry a very large stock so that in the event of epidemics there would be the chance of sufficient animals surviving to enable them at least to carry on. Numbers therefore are considered more important than quality and with overstocking and the consequent shortage of fodder, it is unlikely that the average cultivator would maintain animals of substantial value.

The first essential step towards the improvement of the quality of stock would then be the control of animal diseases and the Imperial Veterinary Research Institute has done good preventive work in this direction, which the amount of production of anti-rinderpest and other sera and vaccines indicates.

NOTES AND NEWS

Referring to the need of having a healthy stock of animals, the Viceroy said that everyone is aware of the necessity of food with effective and balanced nutritive value for the proper functioning of the body. What applies to human beings applies with equal force to animals. Good animals means better and more profitable farming and more nourishing food. The important position which animals occupy in India's economy demands that no effort should be spared to see that the resources of science and technical skill are devoted to examining the improvement of animal nutrition, and that the resulting knowledge on this subject is made available both to the Government department and to the farming community at large.

Canal of the two Seas

At the western end of the Mediterranean Sea, by 1942, may be realized an engineer's dream comparable to that which De Lesseps saw fulfilled at the sea's eastern end in 1869. From recent reports, it appears that work will start on the long projected "canal of the two seas" which will enable big ships to pass from the Atlantic to the Mediterranean through southern France.

Both mercantile and strategic values are attached to this new waterway as cargo and passenger vessels as well as warships from northern ports would be able to reach Marseilles several days sooner and on a reduced fuel consumption without using the straits of Gibraltar.

The waterway's western terminal would be in the Bay of Gironde, below Bordeaux; and its eastern, 240 miles distant, at La Nouvelle near Narbonne. Much of the task of construction would consist of enlargements of the existing Garonne and Aude river channels; the only big new cut required would be across the 40 miles of open country separating Toulouse from Carcassonne. The Canal du Midi, a shallow structure, already links these two towns, and the new cut presumably would follow approximately the same course. Minor cuts would be needed where the rivers follow awkwardly winding courses or the nature of their beds presents engineering difficulties; but these would not be overformidable in number or cost, for at Toulouse and Carcassonne, the Garonne and the Aude after their long descent from the Pyrenees are mature streams. Thus though the new waterway would be between twice and thrice as long as the world's three most famous ship canals, its construction would involve far less radical alteration of the earth's surface. Its affinities would be rather with the vast new internal wateryays of Russia, for which existing river courses have been largely used, than with the complex structures at Suez, Panama, or Kiel.

The project involves the excavation of channels of sufficient depth and breadth to permit sizeable ships to proceed in both directions and pass one another anywhere enroute. The total cost, it is calculated, would be about £20,000,000.

India Meteorological Department

The Report of the Administration of the Meteorological Department of the Government of India in 1937-38, that has been issued, describes the various activities of the Department and summarises the improvements that have been effected during the year. The outstanding developments of the Department was the preparation, in the evening with effect from 1st April 1937, of a second synoptic weather chart at Poona, as a routine measure, that office being thus able to issue two weather forecasts a day. The printing of the afternoon synoptic weather map in the Indian Daily Weather Report together with the map of the next morning has also enhanced the value of the Report to the general public and meteorological services of the world. Another important improvement was the introduction of the broadcast of synoptic data, twice daily, from short wave aeronautical stations at Calcutta and Karachi with effect from 1st August 1937. At the instance of the Royal Indian Navy, broadcasting of synoptic data and weather bulletins for the whole of the Indian waters for the benefit of shipping at sea was also arranged from the Navy Wireless Station at Bombay in addition to the broadcasts issued from the civil wireless stations at Bombay and Calcutta. Along with the expansion of civil aviation, expansion and improvement in the meteorological service was continued. Some current weather stations were opened and night pilot balloon observations started at three stations in the Persian Gulf and at Juhu (Bombay) in connection with the projected seaplane service and the extension of air routes in south India. The existing arrangements along the Trans-India Air route were revised and improved to meet the requirements of the Empire Air Mail scheme. A routine system of exchange of weather reports between the

principal aerodromes on the Karachi—Madras air route was also introduced. Concurrently with the separation of Burma from India with effect from 1st April 1937, the Burma Meteorological Service took over the administrative control of all observatories in Burma, except that of storm warning to shipping in the Burma waters and to Burma ports, which latter work was being done, as in the past, by the Calcutta Office of the India Meteorological Department. The Burma Meterological Department began broadcasting of synoptic data of stations in Burma from October 1937.

An idea about the activities of this Department can be had from the fact that more than 61,000 messages were issued to shipping, aviation, railways, agricultural and other public interests.

Besides the routine activities mentioned above a fair amount of progress was maintained in investigational work. Several special problems of meteorology, aerology, seismology, astrophysics and agricultural meteorology, were undertaken. As a first step in the programme of intensive upper air surveys during cylonic storms, about 250 special ascents of sounding balloons were made at eight places in India during the monsoon season, the main aim being to study properties of air masses giving rise to depressions during the southwest monsoon. Considerable attention was devoted to the subject of the sources of energy of storms and simplified graphical methods of calculating available energy were devised, special attention being given to the role of water vapour as a source of energy.

Calcutta University Convocation

In the course of his address at the annual convocation of the Calcutta University, the Vice-Chancellor, the Hon'ble Mr Azizul Huque, reveiewed the past achievements of the university, its present activities and future needs. In the past, this university has been the pioneer in advancing the cultural needs of our people and the whole structure of our national life and thought has been profoundly affected by this university. It has given the country leaders of political, economic, social and industrial and scientific activities. It has made valuable contribution in extending the bounds of human knowledge and led the people to greater appreciation of arts, literature and science. The teaching and research departments started only about twenty years ago, have done valuable work; but the work has always suffered from want of sufficient funds resulting in paucity of staff and difficulty of maintaining properly equipped laboratories. The laboratories and other buildings of the university are scattered all over the town and there is no room for extension or accommodation of all the branches of higher studies and research. If satisfactory progress of the research activities of the university is to be maintained, the Vice-Chancellor pointed our that there is the immediate urgent need of a well-planned and properly designed laboratory.

If the university is to provide for greater facilities for more knowledge and opportunities for further studies and research, greater financial aid must be forthcoming from the State as well as from private persons for necessary expansion and proper maintenance of the activities of the university. It can also reasonably look forward for such aid to the industrial concerns in the country, who are undoubtedly benefited from studies and research in the university. The Vice-Chancellor made a special appeal to notable firms and industrialists in the province to assist the university by extending financial aids and by appointing larger number of its scholars for research and specialized work in the industrial concerns.

Science in Industry

Electricity in Poultry Farms

During winter when hens are found to lay eggs sparingly, a large-scale poultry farm in Pennsylvania has taken recourse to electricity to increase the egg production. In 23 covered-in coops light is provided to give 12 hours of daylight in winter which is controlled automatically. This 12 hour-day allows the hen to eat and drink more than usual in the cold months and therefore increased egg-laying is assured. This long-day treatment has been found to be effective only during the winter months. It has been reported that late-maturing pullets can be induced to prolong their laying season by two months. The eggs which are commonly laid in winter are "soft shell" eggs. These eggs crack easily. To remedy this defect, ultra violet radiation is used which increase the calcium assimilation of laying stock and the additional chalk hardens the shell. Another interesting result obtained in the farm is that sterilizing ultra-violet radiation has decreased chick mortality from 20 to 1 per cent. For a farm of 2000 hens the experimental results may be tried profitably. The farm referred to, uses electricity in brooder house for warmth and in barn for mincing and grinding food.

- From the *Beama Journal*.

Electricity Consumption in Great Britain

The *Beama Journal* reports, that "the output of electricity in Great Britain rose during the past year by 1,474,000,000 units." Returns rendered to the Electricity Commissioners show that the total number of units generated by authorized undertakers was 24,376,000,000 units compared with 22,902,000,000 units in 1937—an increase of 6.4 per cent. The rate of expansion showed marked fluctuation during the year. In March and April the rate of increase fell away to 1.8 and 0.9 per cent respectively but rose to 14.4 in May. June (2.4 per cent) and November (2.7 per cent) were also low points. The effects of the slowing up of trade and industrial activity was most pronounced in the early part of the year and the abnormal weather conditions in December are reflected in the rise in the percentage increase for that month to 7.1.

The growth in the demand for electricity has been continuous over a long period of years, and, with the steady development which is taking place in the use of electricity for all purposes, the prospects are that ever higher demands will have to be met by the electricity supply industry. Within the past six years the output of electricity from the public supply systems has almost exactly doubled, the output for the year 1932 being 12,241,000,000 units.

During the year the capacity of the selected stations associated with the Grid system was increased by bringing into service some 700,000 kilowatts of new generating plant and boiler plant, with an evaporative capacity of 8,000,000 lb. per hour, which had been ordered in previous years. To meet the demands for electricity which it is estimated will be required during the winters of 1940 and 1941 the Central Electricity Board last year, with the approval of the Electricity Commissioners, made arrangements with the owners of the selected stations for a further increase in the aggregate capacity of those stations by some 800,000 kilowatts of new generating plant and 11,000,000 lb./hour of boiler plant. The capital expenditure involved in these extensions is over £14,500,000."

Vitreous Enamel for Chemical Plant

Speaking before the graduate members of the Institution of Chemical Engineers, England, Mr W. E. Benton explained the properties of enamel that should permit its use in chemical industries. Vitreous enamel

has been described as a glass adapted to adhere to metal. To make this glass resistant to chemicals, there must be present in the enamel a mixture of definite proportions of alkali silicates and the alkaline earth silicates. The coefficient of thermal expansion of the ground coat and that of the cover coat should be adjusted between 290 and 300 (that of cast iron being 330) to ensure proper adherence between glass and metal. An increase of silica usually raises the acid resistance but at the same time lowers both the tensile strength and the coefficient of expansion; boric oxide increases the strength, but beyond a certain limit it damages the resistivity. For chemical plants it is best to use an enamel of high melting point. This enables the gas, which is given off by cast-iron or steel when heated to 600-700°C during process, to escape before fusing the enamel and thus prevents the formation of pin-holes on the enamel surface. As the dry process of enamelling enables the use of a very hard and highly resistant enamel, fusing at about 900°C, the process is recommended for manufacture of chemical wares. Cast iron vessels having no joints are suitable for manufacture of these wares; steel-vessels, on the other hand, are to be welded and these welds are sources of pin-holes. Much attention and care should, however, be given to the design and method of casting the vessels to be enamelled. The heat transfer coefficient of enamelled wares, reported by Mr Benton, is 45 B. T. U per sq. ft. per hour per 1°F difference of temperature during heating up and 80 B. T. U during evaporation. Vessels up to a capacity of 12000 gallons and provided with steam jackets, stirrers and capable of withstanding high pressures are, at present, enamelled at the Cannon Iron Foundries Ltd., England. These wares are highly resistant to all chemicals except alkalies. The most corrosive acids such as 2% sulphuric acid and 5-10 % oxalic acid only slightly destroys the glaze after prolonged periods of working. Zinc chloride and sodium sulphate, when evaporated to dryness in such vessels, attack these very slowly.

Industrial Protection against Air Attack

To protect the industrial plants, public utility undertakings and the men employed there, in case of air attack in any future war, there should be a number of smaller shelters of large one and these should be preferably be situated below the ground level, or failing which, on the ground floor and should be gas-proofed by making them air-tight. Trenches dug on open ground are proof against almost everything except a direct hit and therefore they should be constructed on a staggered system, so that in the event of a direct hit a part of the system may only be destroyed. There should always be two separate means of entrance and exit and all entrances should be provided with air locks as prevention against poison gas. Gas-proof shelters should be equipped with ventilating plants where the air will be drawn through an active carbon filter. Such shelters, if not ventilated, can only afford accomodation to one person per 75 sq. ft. of interior surface area. As regards the main buildings, they will generally be protected with sand bags. In the main plant inflammable articles should be stored under-ground and all glass windows should be screened with dark blinds and protected by wire netting. Internal lightings and illuminations should be reduced by reduction of voltages and introduction of filters.

These are some of the methods pointed out by Mr A. P. Portchmouth at a meeting of the Institution of Chemical Engineers, England. He suggested certain materials for shelter construction and plant protection, such as mild steel plate of 1½″ thickness; hollow structure of 15½″ thickness, with a 2 inch cavity, built of stock brick on cement mortar. According to the speaker, 10″ reinforced concrete have been found to resist the punching shear effect of the splinters, which may induce tensile stresses between the front and the rear faces of concrete walls. Rectangular links, connecting back and front reinforcements, of ¼″ diameter rods at 12″ centres form a suggested arrangement which has been tested successfully. A 2-ft thick wall of shingle contained between wood or sheeting is also effective.

Electric Power in Italy

Italy has no abundant water supply nor easy sources from which she can draw sufficient electric power. But this handicap has been overcome by the construction of seasonal reservoirs. 20 generating stations are fed by 12 such storage reservoirs, the Tirso reservoir with a capacity of 370 million cubic meters being the largest in Europe. Out of the total energy generated, 44 per cent supplies motive power for industry and 35 per cent is used to generate heat, mainly for electrochemical and iron and steel industries. In the electrification of railways only 10 per cent of the

energy is consumed and in Europe Italy has the longest electrified track of 3000 miles. Lack of a standard system of eletrification has hindred more progress, in this line which concerns the State and private owners as well, as a part of national plan for using water power. Besides these, though much is said about the role of electricity in irrigation and other agricultural schemes, in Italy they are consuming only 1 per cent of the total output of energy in spite of much pubicity. Consumption of power, therefore, is more directed towards industrial plants to make her a powerful self-sufficient country.

In India, people have developed a soft heart for rural welfare and much propaganda is being carried in favour of harnessing electricity for the service of agriculture and thus enriching the people of this untry, which is predominantly agricultural. United Provinces a very costly grid system of electrification (the Upper Ganges Hydroelectric Scheme) was launched ostensibly for the amelioration of the hardships of the agricultural population. But it is well known that unless there is a constant load, the capital sunk on such projects can never bring their proper return, and agriculture, from its very nature cannot assure a constant load. This is verified by negligibly small consumption of electricity for agricultural progress in Italy as also in Russia.

Indian Roads Congress

The Indian Roads Congress concluded its fifth session recently in Calcutta. The Roads Congress had standarised units of weight, measure and cost to be used in road specifications, estimates and reports; and form for recording particulars of eperiments carried out on roads, had standardised specifications for sizes of stone metal and nomenclature for bituminous materials and types of construction. It had also laid down standard method of recording traffic statisics and had given attetion to the standardization of road signs. The Roads Congress had been responsible for the Government of India undertaking to finance the establishment of a Test Track at the Government Test House, Alipore, and a scheme of soil research in connection with earth roads. Actual tests on roads constructed under varying conditions of climate and traffic using different materials in different proportions would take years of experimentation while comparative results could be arrived at in a short time on the Test Track.

In opening the session, the Hon'ble Maharaja Sris Chandra Nandy, Minister of Communication and Works, Bengal, stressed on the need of improvement of bullock cart and of the improvement of the resistance of the roads. Emphasizing the importance to this country of the problem of unmetalled roads, the Maharaja thought that the unmetalled road and the bullock cart, hard though the latter was on the former, were likely, for many years to come, to be the principal factors in goods transport for the millions of people who were engaged in the cultivation of the soil.

Suggestions that the bullock cart traffic should be discouraged on new roads would, however, find disfavour among the public because a restriction on such a large scale without providing for similar cheaper methods of transport will very seriously affect the commodity markets, specially that of the agricultural produce.

A Synthetic Fuel Industry for India

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In view of the recent world events, one can no longer think of an automobile industry, without thinking at the same time, about the fuels that would be consumed in motor engines. In pre-War days, the primary source of motor fuel all over the world was the naturally occurring petroleum. In India we depend entirely on this source even to-day. Since the War and particularly in recent years, the European countries have been trying to be independent of foreign supplies of commodities, particularly those which are of vital importance in times of war. Naturally, therefore, countries having an inadequate or no natural source of

petroleum, are preparing synthetic motor fuel from raw materials of which there may be an abundant local supply. Various substitutes for petrol, solid, liquid and gaseous are in use. The cost of production is of secondary importance. To be self sufficient at any price, to keep the people employed and to utilise the indigenous resources, are the guiding principles now in vogue. The extent of substitution as achieved so far in Europe will be evident from the following Table.

consideration in Turkey. The Government of Australia appointed some time back a committee to enquire into the economic possibilities of an oil-from-coal industry in Australia.

Another method of preparing synthetic motor fuel from coal is known as the Fischer-Tropsch process by which motor fuel, kerosene, Diesel oil and paraffin wax can be obtained. Even low grade coal can be utilised as the starting raw material. The production of one ton of oil requires approximately 5 tons of coke if this

TABLE I.

*Amount of Substitute Fuel Consumed in 1937.**

Country	Total Substitutes in Tons.	Total Light Motor Fuel Consumption in Tons.	Percentage of Substitutes.
Germany	1,411,200	2,587,200	54.5
Estonia	7,154	14,014	51.9
Czechoslovakia	61,348	215,600	28.5
Lithuania	1,268	5,586	22.7
Hungary	13,344	67,718	19.7
Poland	17,596	96,236	18.3
Lativa	3,385	19,012	17.8
Yugoslavia	3,730	29,596	12.6
Belgium	35,966	400,624	9.0
France	242,942	2,770,460	8.8
United Kingdom	384,160	4,743,200	8.1
Italy	36,260	473,830	7.7
Austria	10,290	143,374	7.2
Sweden	15,432	193,136	3.1
Holland	10,584	384,748	2.8
Finland	2,842	110,250	2.6
Switzerland	2,989	199,822	1.5

* From the *Petroleum Times*, *15*, 48 1938.

Synthetic Oil from Coal

The researches of Bergius revealed the most important fact that coal can actually be converted into oils under certain conditions by the action of hydrogen. Large-scale plants are operating or about to operate for production of petrol from coal, low-temperature tar, creosote oil, and crude petroleum, in Europe. A good deal of activity in this direction has also been shewn by other countries. Japan's "Seven year plan" for the home production of liquid fuel is well-known. Plants for the synthesis of liquid fuels are under construction. Synthetic plants are also under

is used as the raw material or the same amount of coal if this is gasified completely. Of course, the amount varies considerably according to the kind of coal used.

Though of a later development, the industrial success already achieved by this process is comparable with that attributable to the Bergius process. In Germany both the Bergius and the Fischer-Tropsch processes have made great strides in solving her oil problem. The estimated production of motor spirit by this method early in 1937 was at 150,000 tons. Several large companies have recently been formed and as a consequence, the total production will be at the rate of

530,000 tons yearly when all the plants are functioning. One plant which is operating in France, produces motor fuel at the rate of 13,000 tons per year. There are, on the whole, already eight plants operating in Europe and the total yield this year will rise to a pitch of about 600,000 tons. The Synthetic Oils Ltd., are erecting for trial a small commercial scale plant in Scotland with provisions for extension to a large scale economic size plant. The building of three large scale Fischer-Tropsch plants for Japan by the Koppers Co. of Essen has, most probably, been completed by now. It is stated that the Government of Japan are planning an annual production of 85,80,000 gallons of motor spirit and 46,400,000 gallons of heavy oils by this process. There was a proposal in Czechoslovakia to start a factory to meet 15% of the total consumption of petrol. The erection of a plant is also stated to have been planned for South Africa. The Australian Government as mentioned before, are exploring the economic aspects of the oil-from-coal industry as a whole.

Benzene Motor Fuel

When coal is heated to a high temperature (800° 1000°C) in absence of air, gas tar and coke are obtained. Benzene is present both in the gas and the tar. It can be removed from the gas by scrubbing with oil or activated carbon. Tar is distilled to recover the benzene motor fuel present. In this way, a maximum yield of 3 gallons of benzene per ton of coal can be obtained. Benzene, which has got high anti-knock properties, is used generally as a blending agent for low grade motor fuels to raise their anti-knock value. The production of benzene motor fuel in the different countries of Europe will be found in the following Table.

TABLE II.

*Production of Benzene Motor Fuel in Different Countries.**

Country	Tons
Germany	321,400
Czechoslovakia	11,760
Hungary	3,038
Poland	9,800
Belgium	35,966
France	78,400
United Kingdom	225,400
Austria	8,036
Sweden	490
Holland	10,584
Finland	196
Switzerland	2,940
Total	808,010

* From the *Petroleum Times*, *15*, 48, 1938.

The consumption of the benzene motor fuel, as shewn in the above Table meant for the consumers in Europe a cost of £9,892,600 in excess of what it would have been if gasolines were burnt instead. But in spite of this, the industry is protected to make its diversion possible to the manufacture of explosives in times of emergency.

Alcohol Motor Fuel

In Europe, Germany and France consume a huge volume of power alcohol. Alcohol blends varying from 10 to 6.9% have been used in Germany and that from 10 to 30% in France. Due to the shortage of alcohol, synthetic methanol also is being used for the purpose in Germany since 1936. The consumption of power alcohol in these two countries from year to year, is shewn in the following Table.

TABLE III.

Consumption in tons of Power Alcohol in France and Germany.†

Year	Germany	France	European Total.
1930	?	27,440	57,820
1931	49,000	51,058	118,580
1932	93,100	67,718	178,360
1933	132,300	176,400	354,760
1934	166,600	198,940	436,100
1935	166,600	314,874	564,480
1936	202,860*	297,822	633,080
1937	205,800*	150,322	499,800

* Includes methanol.

† From the *Ind. Eng. Chem.* *30*, 1098, 1938.

The following Table again shows the power alcohol consumption in the different countries of Europe during 1937 and the percentage of power alcohol in comparison with the total weight of motor fuel consumed in those countries.

TABLE IV.

Power alcohol consumption in tons in different countries in 1937.

Country	Power Alcohol Consumption	Total Light Motor Fuel Consumption	Percentage of Alcohol Substitute.
Germany	205.800	2,587,200	8.0
France	150,332	2,777,460	5.0
Czechoslovakia	49,588	215,600	23,0
Italy	36,260	473,830	7.6
United Kingdom	15,680	4,743,200	0.3
Sweden	14,896	493,136	3.0
Hungary	10,290	67,718	15.2
Poland	7,840	96,236	8.1
Yugoslavia	3,724	29,596	12.6
Austria	2,254	143,374	1.6
Lativa	2,156	19,012	11.1
Lithuania	1,274	5,586	22.7
Total	500,094	11,651,948	4.3

We find however that in the United Kingdom the amount of power alcohol consumed is a negligible fraction of the total quantity of motor fuel utilised. In Czechoslovakia and Lithuania, the percentage reached values as high as 23 and 22.7 respectively. Great Britain has never enforced the use of power alcohol for blending purposes. This is partly due to the fact that the raw material, molasses, will have to be imported for the purpose. As a matter of fact, the British Government has recently imposed a tax of 9d per gallon upon alcohol produced from imported molasses. Otherwise probably Indian molasses might have found a market in Great Britain. But while the sale of gasoline during the first quarter of the year amounted to 324,000,000 gallons as against 319,000,000 gallons in the same period last year, the alcohol sales increased from 13,000,000 gallons to 14,800,000 gallons in spite of the tax, as mentioned above, on the sale of power alcohol.

In Japan, the Monopoly Bureau of the Department of Finance has decided to appropriate 1,000,000 Yen (Rs. 13,30,000) for the construction of five alcohol plants during the year 1938 39. Encouraged by the alcohol monopoly law, Takashi Iron Works of Osaka, has so far built seventeen units, the largest having a daily capacity of 425 hectolitres (9350 gallons) of 99.8% purity. In Formosa, by the end of the year 1938-39 an annual capacity of 350,000 metric tons (14,000,000 gallons)* will be available.

In most European countries, particularly Germany and France, the alcohol industry is heavily subsidised. In Germany a subsidy of 19.5d. and in France that of 18d. per gallon are allowed. The total monetary loss by way of tax remission, subsidies and extra cost to consumer that was borne by different European countries during 1937, will be clear from the following Table:

TABLE V.*

	Rs.
Germany	42,00,89,810
France	12,19,01,150
United Kingdom	4,93,32,360
Italy	1,10,27,030
Czechoslovakia	80,66,450
Hungary	44,62,150
Yugoslavia	24,73,800
Sweden	22,05,140
Poland	15,53,440
Latvia	11,18,530
Austria	10,20,110
Estonia	7,51,450
Lithuania	4,82,790
Finland	2,60,680
Total	Rs 62,47,44,890

* From the *Petroleum Times*, 15, 50, 1938.

The huge loss of Rs 62,47,44,890 due to compulsory use of power alcohol indicates, in clear terms, how intense is the desire of European countries, particularly, of Germany and France, to protect their alcohol industry. This desire is interpretable, as a measure not only against a shortage of motor fuel in time of war but also against a shortage of munitions for which alcohol is a prime material. This interpretation is substantiated by a recent report of the Mining and Power Commission of the French Chamber of Deputies, which runs thus: "So far as alcohol is concerned, war time requirements for the explosive industry, for solvents and for medicinal purposes, would be so great that they would far exceed the domestic production." The sharp decline of alcohol used in motor fuel during 1937, finds a possible explanation in its diversion towards the preparation of explosives. The repeated war threats have made the use of alcohol in any substantial quantities as a motor fuel, more or less impossible at the present moment. In Italy, at present, oil companies are no longer compelled to blend alcohol with regular grade gasoline.*

Compressed Fuel Gases

The introduction of light alloy cylinders made possible the use of compressed gases as fuel in motor vehicles. The police regulation permitting their use gave the needed impulse for the adoption of gas propulsion for motor cars in Germany and it is estimated that over 150,000 tons of gasoline have been replaced by compressed gases during 1938. The use of compressed gas as a fuel is the greatest in Germany. Italy comes second in the list. There are already 500 buses and trucks in Milan and Florence area using compressed natural gases. At present, about 40,000 tons of petroleum gasoline are replaced by natural gases per year. The use of these cars is encouraged by the Governments of Germany and Italy by a reduction of the taxes payable.

In Stuttgart, sewage gas has also been successfully used. It contains 7.95% methane when freed from carbon dioxide and hydrogen sulphide. One cubic metre (35.3 Cu. ft.) of the crude gas is equivalent to 11c.c. of petrol.

The road transport is becoming more and more important in India. The railways are finding the competition very keen in certain areas. In England nowadays, no fewer than 1,272,000 persons are engaged in road transport whereas only 675,000 are employed in the railways. Though reliable figures are not available, it is true that in India too, as in England, the road transport is gradually gaining ground over rail transport. The Indian Motor Vehicles Amendment Bill of 1936 is indicative of the importance that road transport has acquired in recent years.

Though it is possible that substitute fuels will be used in the road transport, the consumption of gasoline type fuel will still predominate in India for years to come. Aviation also will continue to take more and more important part in the matter of transport in India. The consumption of aviation spirit will gradually increase on that account.

Practically, the whole of India's petrol requirement is drawn from foreign countries. Of 103,198,943 gallons of petrol consumed during the year 1937, only 15,419,479 gallons were produced internally whereas 38,149,143 gallons were imported from Burma and the rest from other foreign countries.*

The reasons, which prompted the British Government in 1933 to pass the British Hydro-carbon Oils Product Bill, protecting indigenous production of motor fuel and thereby clearing the path for erection of the well-known Billingham plant, also exist in India. Further, as in England, so also in India the coal industry is not in a flourishing state. A plant of the Billingham type having production capacity of 150,000 tons of motor spirit annually, consumes 600,000 tons of coal, thereby, finds employment for 2000 workers in the factory and for 2000 miners in the coal fields. In the following table, are given the amounts of import duty and the tax imposed by the different governments to subsidise their respective indigenous motor fuel industries.

Economics of the Oil-From-Coal Industry

As a compromise between the estimates by the Imperial Defence Committee of Great Britain, the

* The readers will find it interesting to read the article on Power Alcohol which appeared in SCIENCE AND CULTURE 4, p. 228, 1938.

* Data kindly supplied by the Director, Geological Survey of India.

TABLE VI.

*Import Duty and Tax Imposed on Motor Fuel**

Country	*City*	*Gasoline Price Annas Per gallon.*	*Import Duty Annas Per gallon.*	*Import Duty and Tax Annas Per gallon.*
Italy	Rome ..	.. 39.0	26.2	27.2
Germany	Berlin ..	.. 31.8	16.6	19.2
Lithuania	Kaunas ..	.. 33.7	12.4	12.4
Bulgaria	Sofia ..	.. 26.7	15.0	20.8
Czechoslovakia	Prague ..	.. 22.6	2.7	8.6
Palestine	Jerusalem	.. 22.1	11.1	11.1
Yogoslavia	Belgrade ..	.. 21.8	3.6	12.5
Switzerland	Zurich ..	.. 20.4	10.3	10.3
Hungary	Budapest	.. 20.3	4.3	13.9
Estonia	Tallinn ..	.. 20.3	4.3	11.3
Latvia	Riga ..	.. 20.2	7.7	11.5
Greece	Athens ..	.. 20.0	10.6	11.3
United Kingdom	London ..	.. 19.3	8.0	8.0
Belgium	Antwerp ..	.. 19.2	10.7	10.7 + 9% *ad valorem*
France	Paris ..	.. 17.0	9.9	10.4
Norway	Oslo ..	.. 14.7	none	5.1
Denmark	Copenhagen	.. 14.1	none	5.9

From *U. S. Bur. Mi Economics and Statistics Branch 6, 1938.*

British Labour Party and the Rivett Committee of Australia, the cost of light motor spirit by both the Bergius and Fischer-Troosch processes may be taken to be practically the same, ranging from about 9.3 d. to 11.5 d. per gallon, according as the life of the plant is supposed to vary from 10 to 20 years. It has also been learnt through an authoritative source that I. G. Farbenindustrie's cost of production is about 11 d. per gallon.

In England, petrol costs about 3d. ex-store and is subject to a tax of 8d. making a total of 11d per gallon. The price of petrol is Rs. 1-2 as. per gallon in bulk at Calcutta. The retail price of petrol in London is about 21.7 d. (Rs. 1-3 as.) per gallon. Even if the cost of production of synthetic petrol is taken at 11.5 d. (9 as.) per gallon, there exist immense possibilities of the oil-from-coal industry in India, if only the excise tax on synthetic petrol be regulated with a view to maintain its price level on a par with natural petrol.

There exist, further, the following significant factors in favour of the economic soundness of the industry in India. Though the price level of petrol is higher in India than in London, the value of coal at pit's mouth in India is much lower than in England, where it is roughly 13 s. 4 d. (Rs. 8 14 as.) per ton of coal, whereas in India it is scarcely higher than Rs. 3. Since about 33% of the running costs in a synthetic oil-from-coal industry, is due to the coal consumed, the cost of production will be much lower in India. This fact and the lower labour cost are significant points of advantage ensuring commercial success for the process.

A lower capital expenditure will also be involved due to the experience already gained in Europe, in the construction of the two typical German plants.

According to C. Berthelot, it is best to combine the hydrogenation of primary tar and oil with a process of the catalytic production of oil by the Fischer-Tropsch process from carbon monoxide to which the resultant coke can be converted. Production cost works at 800 R. M. (Rs. 532) per tonne (0.98 ton)year of spirit with direct complete hydrogenation of lignite by the Bergius process, while by the Bergius and Fischer Tropsch combination process, a 600 R. M. (Rs. 399) per tonne year is realisable.

The danger of operating very large units, small in number, producing commodities for national defence

is too apparent to need elaboration. On the other hand, maximum relief to unemployment can also be derived on the operation of a process in a relatively smaller economic units consuming the whole output of a colliery, which may in some cases, find poor demand for its particular coal by reason of its bad coking properity or otherwise.

It is well known that in India first class coking coals are comparatively rare. Non coking and low grade coals of which there is a huge reserve of about 58,300 million tons and for which there is practically no good market, can profitably be utilised by the Fischer Tropsch process or the Bergins and Fischer-Tropsch combination process. The Assam coals only, which have got more or less 80% of carbon no more than 2% of ash and are highly volatile but which suffer from the drawback in having a high sulpher content, appear to be perfectly suitable for hydrogenation by the Bergins process. Estimation shows that we have in Assam a reserve of about 600 million tons of such coals.

Capital Expenditure

The capital expenditure of the Billingham plant which was designed to produce annually 100,000 tons of light spirit from coal and 50,000 tons from low temperature tar and creosote was about £5,500,000. According to the Imperial Chemical Industries Ltd., the minimum size of a hydrogenation plant producing oil from coal only, is one having an annual output of 150,000 tons of motor fuel. The capital expenditure is calculated at about £8,000,000 (Rs. 10,64,00,000.) under the following items:

	£
Capital cost (plant, materials etc.), General services and workshops	1,035,000
Boilers and power plant	1,570,000
Gas making, purification and compression ..	1,762,000
Hydrogenation plant and refinery ..	2,880,000
	7,247,000
Sundry charges (research during construction, interest during construction, working capital, International Hydrogenation Patents fee)	750,000
TOTAL ..	7,997,000

The following are the recommended sizes of plants with estimates of capital costs for the Fischer Tropsch process, from the report of the Imperial Defence Committee of Great Britain.

20,000 ton plant (including coke ovens) ..	£1,000,000 to £1,500,000
35,000 ton plant (including coke ovens) ..	£1,901,000
35,000 ton plant (Direct gasification of coal in water gas plant) ..	£1,717,000
60,000 ton plant (including coke ovens and distillation plant) ..	£3,100,000

These estimates are based on the information furnished by Ruhr Chemie A. G. at different dates. They, therefore, depend upon the market rate on the dates under question The following figures are quoted from the British Labour Party's report on Fischer-Tropsch plants.

	Cost of plant.
Capacity, 35,000 tons of primary product (or 28,350 tons of motor spirit, the Diesel oil fraction being cracked) from Bituminous coal. Self-contained plant with coke ovens ..	£1,900,000
10,000 ton capacity without coke oven to work in conjunction with a coal distillation unit and to produce synthetic products from low temperature coke	£225,000

It is clear from the estimates given above that the smallest economic unit for the Fischer-Tropsch process involves a lay-out of smaller capital expenditure in comparison with that of the Bergius process. The capitalists will be encouraged to invest the necessary money for starting this most important defence industry in India if the Government of India, following the British Government, comes forward to protect it and ensures the continuance of its fostering care for a number of years to come. The form and the extent

of assistance should provide for price fluctuations of products, labour and raw materials.

Researches on Oil Synthesis

It is wellknown that the preparation of synthetic oil from coal is the result of intensive researches of Bergius, Fischer and collaborators. The practical developments in Germany, of the Bergius process for getting light motor spirit from the German brown coal, are mainly due to the investigation of I. G. Farben—industrie A. G. and that of the Fischer-Tropsch process to the researches of Ruhr Chemie A. G. The amount spent on these researches is immense. A number of important investigations are still in progress in Germany, for further improvements. The Imperial Chemical Industries Ltd., developed in England, the Bergius process for obtaining motor spirit from the British bituminous coal. The amount spent on the researches by the I. C. I. from 1927 to 1933 was £1,000,000 (Rs. 1,33,00,000). As a matter of fact, investigations are in progress all over the world, and particularly in oil less countries of Europe, to find out a process suited to the particular raw material. In plants of Azienda, Nazionale Idrogenazione Combustibili—a new hydrogenation process suitable for Albanian crude, will be used. This is an Italian invention increasing yields from 40% to 80%.

Even the countries like Russia and the United Sttaes of America, having vast natural resources of mineral oil are interested in the oil-from-coal processes. A pilot plant for the continuous hydrogenation of 100 lbs. of coal per day, has been built in the Pittsburgh experimental station of the United States Bureau of Mines. A number of papers has been published from Russia, particularly on the Fischer-Tropsch process and on the hydrogenation of petroleum. The Governments of almost all the countries of Europe and in Asia, particularly of Japan, not only subsidise the indigenous oil industry but also finance investigations on the synthesis of oils.

Investigations in the British Empire

There are definite signs of interest shown by a number of Governments in the British Empire. That shown by the British Government in England is the keenest. The amount that is being spent annually on these researches by the Fuel Research Board is enormous. This institute is financed by the Government and about £10,000 (Rs. 1,33,000) are spent annually. Investigations by this Board on the hydrogenation of British bituminous coal was started in 1923. After a study of catalysts, experimental plant of 1 ton per day capacity was constructed and worked until the erection of the Billingham plant. It is true that these researches had much to do with the industrial development of the Bergius process in England. Later on, a semi-technical scale plant for the hydrogenation of tar with a throughput of raw materials 200-400 gallons per day, was constructed and has been operating since 1935. Recently, attention has been focussed on the Fischer-Ttopsch process. A plant large enough to convert hourly 100-150 cu. ft. mixture of carbon monoxide and hydrogen into hydrocarbon, was designed and constructed in 1936. It is now in operation.

The encouragement of research in England in these lines will be further supported by the following statements of the Falmouth Committee. "The Fischer process merits close investigation in this country, particularly the possibility of the production of Diesel and lubricating oils, unsaturated hydrocarbon gases and high octane fuels. Research work in this process is being carried out at the Fuel Research Station, and the Committee hopes that this will be continued, but believes that the determination of the value of the process to this country can only be secured if a plant on commercial scale is available."

"The Committee considers that it would be of considerable advantage, if the establishment of a plant to work the Fischer process designed for the production of not less than 20,000 to 30,000 tons of primary products per annum could be secured........".

"The Committee agrees that the research should be continued."

The British Government's decision to extend the tax preference of 8 d. per gallon of petrol for a period of 12 years from 1938 will certainly stimulate research for further improvement of the oil-from-coal processes.

The interest shown by the Government of Canada is indicated by the investigations that are being carried out with Canadian coals in the fuel research laboratories of the Department of Mines. The present equipment has a throughput capacity of 1 gallon raw material per hour based on continuous operation. The Fuel Research Institute of South Africa is another Government Institute carrying on researches in this direction with

African coals. The Government of Australia has shown much concern in the problem as is reflected in the appointment of a committee to enquire into the economic possibilities of oil-from-coal industries in Australia. The lack of interest in the matter by the Government in an almost oilless country like India is conspicuous. A part of the income derived from the cess on coke may rightly be utilised for researches with a view to find out methods adaptable to the hydrogenation of Indian coals. These researches concern a defence industry and as such, an amount may rightly be ear-marked for this purpose, also in the military budget for the defence services.

Crude Oil Refinement

It is, however, true that the importation of motor spirit will not be cut off completely unless a blockade is made, nor till the synthetic oils like the synthetic ammonia can successfully compete with the natural product. But the importation of light petroleum spirits can easily be replaced by that of the natural crude, with an immediate economic advantage provided the refining is carried out in India. The importation of the cheap raw material instead of the more expensive finished product means a lower expenditure on foreign goods. The establishment of refineries in India will also help to bring down the rolls on unemployment. The refineries of Italy supply about 50% of the country's total gasoline requirement by distilling imported crude. The following quotation from a report of the Indian Tariff Board will be of interest. "It stands to reason that all these countries would not have deliberately established refineries if it was cheaper to import refined product...... ."

"Further, two important branches of oil business today namely refining and marketing are almost entirely in the hands of companies registered outside India. A substantial part of this business can be converted into a genuine Indian enterprise if refineries are established in India and oil is marketed by Indian companies with Rupee Capital. It might be possible to encourage the establishment of refineries in India by Rupee Companies if the present import duties on crude oil of 2 as. 6 p. per gallon was retained but was remitted in favour a genuine Rupee Company subject, of course, to usual condition on which a bounty is granted and such other control as the Government may impose. No doubt, if this business was undertaken by any company outside the big Oil Trusts, attempts would be made by unfair competition to bring it to grief but it should not be impossible for the Government to afford protection against such competition by varying the import and excise duties in force for the time being on refined products or in some other effective way."

But in India no plant is known to exist till today for distilling the imported crude petroleum. A British concern, however, has recently sought permission of the Ceylon Government for erecting such a plant. We import per year roughly 100,000,000 gallons of petrol etc., 200,000,000 gallons of kerosene, 130,000,000 gallons of fuel oils and 10,000,000 gallons of lubricating oils. Percentages of the yields of the four important products of the crude oil distillation are roughly as follows. Petrol....30.9%, Kerosene.... 9.4%, Lubricating oil ....4.4%, Gas and Fuel oil .... 49.4%, From the above figures it is quite clear that if the quantity of petrol which we must import are produced by refinement of the imported crude oil, none of the other products will be produced in amounts in excess of our present requirements.

MEDICINE AND PUBLIC HEALTH

Nutritional Survey

The Technical Commission of Nutrition of League of Nations emphasize in their report on the importance of diet in relation to health problems in the East. They thing that health depends much more on proper nutrition in the East than in other parts of the world. To remedy the lack of interest in this matter, the conference urges that "National Nutrition Committees should be established in each country and that they should include representatives of the public health, medical, educational, agricultural, animal husbandry and fisheries departments. In addition, there should be a central research institute in each country, specialising in nutrition, and a similarly specialised technical personnel whose functions would be to promote the practical application of modern nutritional science." They expect that close collaboration should be maintained between national and international organisations.

The Commission specially recommended ten subjects for further study. They are as follows: (*i*) assessment of the nutritional state of children (*ii*) nutritive food requirements during the first year of life, (*iii*) minimum vitamin and mineral requirements, (*iv*) nutritive and supplementary values of the different protein-containing foods, (*v*) determination of the extent and the forms of animal protein necessary for growth and health, (*vi*) relative nutritive values of different cereals according to the degree of milling, (*vii*) harmful effects of increasing consumption of sugar on health, (*viii*) influence of climate on food requirements, (*ix*) analysis of diets in common use which fall below the standards, and (*x*) optimum amount of milk required at different ages.

These subjects were communicated to different societies and scientific institutions of different countries for their co-operation in solving these problems.

Regarding the assessment of the nutritional state of children, the Commission have recommended that after a general survey where large number of children should be assessed a more detailed scientific investigation on far fewer subjects to detect the first signs of malnutrition should be further undertaken. After analysing the collecting data out of a survey of the nutritive food requirements during the first year of life they specially emphasized the need for continuing work on tests for pre-deficiency by the practical application of tests in as many instances as possible. In reviewing the data about minimum vitamin and mineral requirements, minimum fat requirements, the nutritive and supplementary values of the different protein-containing foods, the Commission found the need to carry on studies of the factors influencing the utilisation of calcium and phosphorus, of the proportion of assimilable iron in various food stuffs, of the quantities of iron necessary for adults of both sexes and of the assimilation of iron by children.

They also organised a special enquiry into the hygienic problems involved in the production and distribution of milk and in the chapter on it they have endeavoured to show why milk is a food-stuff of such paramount importance especially during the period of growth and stressed the dangers of milk as a vehicle for bacterial infection and the necessity for pure milk supply. It was also pointed out how skimmed milk might be turned to account.

"Typhoid Mary"

The death of Miss Mary Mallon, a chronic typhoid carrier at New York, recalls the peculiar phenomena of typhoid infection. Miss Mallon was a cook in a house and there four fellow servants contracted typhoid fever. Suspicions were aroused that Miss Mallon might be carrying typhoid bacilli. The suspicions were confirm-

ed when two servants in another household, where she was working later, suffered from typhoid. Similar outbreaks of typhoid fever occurring at varying periods after Miss Mallon's engagement as a cook were further traced. It was found that Miss Mallon had been a faecal, probably biliary carrier. Typhoid bacilli were not found in her urine. She was later isolated and housed at State expenses. 'Typhoid Mary,' as she was called, died from paralytic seizure. Where typhoid is common 0.1 percent of the population are expected to be typhoid carriers, generally 2 to 5 % of all cases of typhoid fever become permanent carriers. The successful treatment of chronic cancer has been hitherto surgical.

Calcium Treatment

There are a number of diseases associated with abnormalities in the absorption, excretion and utilisation of calcium in the system. These may be treated successfully if certain methods are followed. To increase calcium stores in the bones, administrating of calcium gluconate or lactate is not enough. The administration of these should always be accompanied with milk in sufficient quantities or adequate amount of vitamin D. To lower abnormally high blood-calcium, surgery of excess para-thyroid and irradiation of the gland is necessary. To elevate low blood-calcium, calcium cloride should either be given intravenously, or calcium gluconate intramuscularly. Calcium by mouth is useful only in chronic cases. Vitamin C appears to be also necessary. Administration of thyroid gland extracts has been found to be chemically useful. In pregnancy and lactation, thyroid is particularly indicated to help in the utilisation of calcium, administered from outside. The explanation, however, of the role of thyroid in such process is not yet fully understood.

— *Jour. Ame. Med. Assn.*

Strophanthin Therapy

Strophanthin can now advantageously replace digitalis preparations given by mouth, provided great care is taken in the dosage. 10,000 injections have been given with complete success, except in one woman, who started vomiting after even small doses of strophanthin, so that the treatment had to be discontinued. One of the patients has, in the course of seven years, received over 1200 injections, and has been enabled to carry out her household duties. This patient was suffering from chronic auricular fibrication. Strophanthin should never be injected when the patient is already taking digitalis by mouth. As regards the indications for strophanthin, all forms of cardiac insufficiency or failure, whether they be due to valvular or to myocardia disease, in angina pectoris and coronary thromnosis, and actual or threatened heart failure in acute infectious diseases, and particularly in pneumonia, are noted. In the latter, strophanthin is especially valuable, since, in contrast with digitalis, it acts on nonhypertrophied cardiac muscle.

— *Bri. Med Jour.*

Evipan in Cocaine Poisoning

Dr H. J. Daly reports a case which illustrates the antagonism to cocaine and its substitutes, commonly attributed to the barbiturates. A man of nearly seventy was accidentally given a hypodermic injection of three grains of cocaine hydrochloride, and soon showed pallor, rapid pulse and generalised muscular twitchings, particularly of the extremities. As his condition was deteriorating in spite of oxygen and carbon dioxide inhalations and the injection of 1/30 grain of strychnine, 3 c.c of evipan solution were given intravenously forty-five minutes after the cocaine was injected. The convulsions ceased, the pulse rate dropped and the patient slept for about fifteen minutes. Forty minutes later, as severe spasms with pain and dyspnoea had returned, a further 3 c.c. of evipan was given, resulting in ten minutes sleep and improvement on awakening. Half an hour later, as breathing had again become difficult, a further 2 c.c. was given and a short sleep was again followed by improvement and a slower pulse. Four hours after the injection of cocaine he had apparently recovered completely, he slept well after a hypodermic injection of morphine, and showed no ill effects next day.

— *Bri. Med. Jour.*

New Insulin

Protamine-zinc-insulin simplified the treatment of severe diabetes. Its action on the glycemia is prolonged, and retarded and also avoids the alteration of hypo and hyperglycemia that one observes in the severe forms of diabetes in the course of habitual insul-

in treatment. This new treatment renders a great service to the early diabetics and to the sympathecotonic diabetics, notably to those who are impossible to render aglycosuric, because increasing the insulin dose infallibly produces hypoglycemia. In the treatment of mild forms, the average dose of protamine insulin acts in a manner so durable that one is able to space very large injections. The regulation of the glucidic metabolism in the course of the treatment permits one to suspect a diminution, in the future, of the number of injections and likewise the disappearance of the vascular, nervous and ocular complications.

—*Presse Medicale.*

Vitamin C in Tuberculosis

Numerous observers have recorded that vitamin C deficiency in the diet influences unfavourably experimental tuberculous infections in animals. Testing C metabolism in fifty-five sanitorium patients, both early and moderately advanced cases, by estimation of its increased urinary excretion after the oral administration of ascorbic acid, Haefliger found that with the ordinary institutional diet, rich in fruit and vegetables, vitamin C deficiency was rare. Only about 10% of the patients showed an excretory deficit of 1,000 mg. or over, and this deficiency seemed to be unrelated to the course of the illness, the sedimentation rate, or the general condition. Treatment by vitamin C is probably desirable in those patients showing a definite deficiency. Untoward effects, such as, activation of quiescent lesions, have not been noted.

—*Bri. Med. Jour.*

Oral Immunization from Cold

Previous work by Rockwell and co-workers has led them to believe that the presence of the heterophile (Forssman) antibody gives considerable protection against the common cold. Since numerous bacteria contain the heterophile antigen which may be administered orally, these workers have orally immunized persons in previous studies with cold vaccines and reported considerable success. In a recent study, 100 persons were given the oral vaccine and 100 persons, living under similar conditions, served as the controls. The vaccine consisted of 25 billion pneumococci, 5 billion H. influenza, 15 billion streptococci and 5 billion M. Catarrhalis which were heat killed, dried, mixed with starch and placed in a capsule. Each individual in the experimental group took one capsule for seven consecutive mornings and then one capsule each week throughout the remainder of the season. The results indicated that the persons in the control group had four times as many colds as the experimental group, and that the experimental group showed a 67.7% reduction in the number of colds.

—*Journ. Lab. Clin. Med.*

New use of Testosterone Propionate

Suitable doses of testosterone propionate can be used to induce atrophy of a normally functioning endometrium in a pathological state resulting from stimulation by too much oestrin. This action could be explained by supposing that it prevents the ovarian follicle from ripening, perhaps by inhibiting the effective secretion of gonadotropic hormone by the anterior lobe of the pituitary gland. The results recorded suggest that it may be possible to direct and regulate ripening of the follicles by giving appropriate doses of testosterone propionate, and also that this substance will be useful in the treatment of chronic mastitis.

—*Lancet.*

Sulphanilamides

The antibacterial value of the sulphones and sulphonamides was long recognised. The sulpha nilamide or Prontosil alba (Bayer) which is structurally p-amino benzene sulphonamide and also a number of its derivatives have been marketed under a variety of trade names. A near compound to Prontosil (4-sulphamido-2. 4 diamino azobenzene hydrochloride) was isolated in 1919 for use in textile industry. The Prontosils were patented in 1923 and after therapeutic researches, were put into the market for oral administration against haemolytic streptococcic infections in 1935. For injection purposes, a red dye known as Prontosil solution or Prontosil 'S' (disodium salt of 4-sulphamido-phenyl-2 azo-7 acetylamino-1 hydroxy-napthalene-3. 6-disulphonic acid) was evolved. Other substitution products such as proseptasine, soluseptasine, uleron and M & B 693 are also in the market and reported to be effective in different acute and chronic bacterial infections.

Of all the preparations, three drugs are mainly used. Of these three, sulphanilamide has been shown (Long) to be the least toxic and therapeutically most active and is clinically the least complex. The activity of the drug depends on the amino group in the para position as the transference of the said group to the ortho or meta-position renders it inactive. The drug, though soluble, can not be put up in stable solution for marketing. The other two, Prontosil and Prontosil 'S', purported to be stable and convenient, are more complex and more expensive and may even be extremely dangerous. It is also proved that these more complex preparations owe their therapeutic value to p-amino benzene sulphonamide to which they are reduced in the body. Hence it is desired that only the pure and simple drug sulphanilamide should be administered.

By experimental researches Buttle (1936) has proved that the least toxic sulphanilamide can be used in larger doses than Prontosil 'S'. Hence better protection can be given with sulphanilamide against haemolytic streptococcic and meningococcic infections but no protection against staphylococcic or pneumococcic infections. Long (1937) has shown that sulphanilamide in 1/10.000 dilution has a marked bacteriostatic effect against haemolytic streptococci, pneumococci types I and II, neisserae from throat, mocrococcus tetragenous, haemophilia influenzae and haemophilia haemolyticus whereas Prontosil 'S' has no effect in dilutions of 1/100 and 1/1000. It has also been shown by experiment that in meningococcic and type I pneumococcic infections combined specific serum and drug therapy is much more effective.

No action other than the bacteriostatic effect has yet been definitely proved. The supposed enhancement of phagocytosis is not also proved. An ordinary oral dose of the drug is absorbed in about 4 hours from the alimentary canal and its action persists for about 6 hours. Hence for continuous treatment the drug should be repeated every 6 hours. The drug is completely excreted in urine in 24 hours.

To get the optimum basteriostatic effect the optimum level of concentration of the drug in the blood should be maintained, *i.e.*, 10 magm. per 100 c.c. of blood. Roughly a maximum dose of 1 grm. per 20 lbs. of body weight per 24 hours is necessary to maintain the level for first 48 hours. Thereafter it may be cut down for next 72 hours to 2/3 and for next 4 to 8 days to 1/2 or 1/3 of the maximum dose in 24 hours. When the drug is absorbed slowly it may be given subcutaneously or intramuscularly. But it is never necessary to give it intravenously as the drug appears in urine within 15 minutes after subcutaneous injection. When the kidney function is impaired, less drug will be required per 24 hours to keep the blood concentration at the desired level.

For injection a freshly prepared 0.8% solution of sulphanilamide is preferred to Prontasil 'S' as the former is less toxic and more effective as well as less expensive. The dose for intraspinal injection is 10 to 30 cc. after withdrawal of 15-40 c.c. spinal fluid and

for subcutaneous injection 100 c.c. per 40 lbs. of body weight for 24 hours.

In short, oral method is satisfactory unless absorption is impractical. The administration of 10 grains of sodium bicarbonate with each dose of sulphanilamide is of definite value. For success the treatment should not be discontinued too soon.

In acute streptococcil infections, septicaemia, erysepelas and puerperal fever the drug is most effective. The combination of the drug with established surgical procedures is found to be of definite value. In menigococci and streptococci meningitis it is effective. Early treatment is imperative for clinical success. The intraspinal route combined with subcutaneous or intramuscular route is justified. To get more effective result specific serum should be used along with the drug. In gonorrhœa, both new and old and its metastatic affections it is proved to be of value. According to some, the treatment is more effective when begun after the acute stage has passed. In type III pneumococcus pneumoonias some success was reported. Good results were also recorded in gas gangrene.

According to some, the drug has some activity against staphylococci infections. It has also been used in various other infections like typhoid, actinomycosis, etc., but views as to results differ. It is of no use in rheumatic fever. If has no value when used as a prophylactic.

Sulphanilamide and perhaps to a less degree Prontosil and Prontosil 'S' are well tolerated by the majority of patients. The toxic effects vary in different individuals. Minor symptoms such as nausea, lassitude, general malaise, dizziness, depression, mild anæmia and cyanosis are noted especially in ambulant patients. Acidosis may be produced which can be combated with alkalies. More severe symptom as sulphenoglobinemia may be produced by the administration of sulphates as cathartics during the drug treatment. Another, methemoglobinemia may be produced by large doses of the drug *e.g.*, 12-24 grams per day. The former condition should be treated by discontinuance of the drug and repeated blood transfusion and the latter by withdrawal of the drug and administration of oxygen. Fever, called drug-fever, due to a reaction to the products of the dissolved bacteria may occur and this should not be mistaken for a recrudescence of the original infection. There may be rashes as well on the exposed parts. These are usually of no serious nature and do not necessarily indicate withdrawal of the drug. Agranulocytosis is the most serious complication but it is a rare condition. Acute haemolytic anaemia may occur but it quickly responds to blood transfusion after discontinuance of the drug. A frequent blood study is therefore important to determine the damage done to blood forming organs. The drug is excreted through breast milk and so it should be prescribed very carefully to nursing mothers. Puragatives like mag. sulph. and sodi. sulph should be strictly avoided during the treatment to prevent sulphenoglobinemia. There is no specific treatment for the toxic symptoms. The important procedures to be adopted are (*a*) to discontinue the drug and (*b*) to increase the fluid intake.

In view of these observations, it may be concluded that in sulphanilamide we have a highly effective specific against haemolytic streptococcic infections and to a less degree against certain other infections. But it should be properly administered with due regard to the possible occurrence of toxic symptoms.

RESEARCH NOTES

Radio-active Decay of Mesotrons

It is now well-known that Yukawa (*Proc. Math. Phys. Soc.* Japan *17*, 48, 1935) in the course of his investigation on nuclear forces, postulated in 1935 the existence of a particle of mass μ, equal to about 160 times that of an electron with unit spin moment As a consequence of his theory, it follows that such a particle will spontaneously disintegrate into an electron and a neutrino, and the mean life of this particle should be about $\frac{1}{2}\times 10^{-6}$ sec. Further if this particle moves with a velocity βc, its means life $T = \dfrac{T_0}{\sqrt{1-\beta^2}}$

The principles of conservation of energy and momentum require that a heavy particle, when spontaneously disintegrating, will give rise to an electron and a neutrino, moving in opposite directions with equal momentum; further owing to the negligible masses of the electron and the neutrino compared to that of the heavy electron, their kinetic energies at the time of disintegration will be about $\frac{1}{2}\mu c^2 - 40{\cdot}10^6$ e.v.

Recent discoveries of a particle of intermediate mass between an electron and a proton in the cosmic rays have aroused considerable interest in properties of Yukawa's particle, which is now called Mesotron. The mass μ of this particle has been found by many investigators to have values which vary from 150 to 250 times, *m*, the mass of an electron. These particles, when moving with an energy greater than 10^8 of air and water by Ehmert, (*Z. Phys. 106*, 751, e.v. are assumed to constitute the penetrating portion of the cosmic rays. By consideration of the processes by which such particles can lose their energies, the conclusion is drawn that the loss of energy is essentially proportional to the mass (*i.e.* to the gm/cm²) of the matter traversed and is independent of the specific physical nature of the latter. Detailed investigations of the absorptions of the penetrating component of the cosmic rays in equal masses of air and water by Ehmert, (*Z. Phys. 106*, 751, 1937) have shown that the absorption is greater in air than in water. Euler and Heisenberg (*Ergeb. Exak. Naturwiss 17*, 1, 1938) have interpreted the anomaly in the following way. A given beam of mestrons when traversing a certain thickness of matter will be absorbed partly by loss of energy by ionization and partly by spontaneous disintegration; and hence for equivalent mass of matter traversed, absorption of mesotrons will be greater in that medium in which they have traversed the longer path. From Ehmert's data of the relative absorption in air and water, Euler and Heisenberg have calculated the value of T to be about $2{\cdot}7\times 10^{-6}$ sec. which is about five times Yukawa's value.

In a recent communication to *Nature*, Rossi has calculated the value of T from certain absorption measurements made by him and Beneditti (*Phys. Rev. 45*, 212, 1934) in 1934 at Eritrea (lat, 11°30 N+2370 m. above sea level). In this experiment the absorption of the penetrating radiation in different thickness of lead and air was measured, and it was found that the hard component was much more reduced in air. The value of T is calculated on the assumption that the average energy *E* of the radiation is 3×10^9 e.v., T coming out to be about 2×10^{-6} sec.

In the same issue of *Nature* Blackett points out that the measurement by Auger, Ehrenfest and others (*C. R. 204*, 257, 1937) of the Zenith angle distribution of the penetrating radiation at different altitudes above the sea level lead to the conclusion that the absorption of the inclined rays was greater than that of the vertical rays under the same thick-

ness of the absorber. Using the data of Auger and Johnson (*Phys. Rev. 43*, 307 1933) Blackett calculated L, the mean range of the mesotrons to be 23×10^5 c.m. with mean particle energy of 4×10^9 e.v. For the very penetrating component of the hard rays of mean energy 4×10^{10} e.v. whose absorption up to 60 meters or more in water has been measured by Ehmert and others, Blackett finds the range to be about 255 km. The life of mesotron at rest calculated from these data is about $1{\cdot}7\times10^{-6}$ sec. From these observations it may be concluded that the mean life of these mesotrons has been found to have values from 2·7 to $1{\cdot}7\times10^{-6}$ sec.

It will not be out of place to remark that a number of ionization tracks of mesotrons at the end of their range has been photographed by Maier Leibnitz (*Naturwiss, 26*, 677, 1938). In one of Maier Leibnitz's photographs, the end of the track of mesotron is seen to be associated with a track of light electron. This appears to verify the assumption of Euler and Heisenberg, that the mesotron disintegrates spontaneously into an electron and a neutron track in the magnetic field, its energy appears to be much less than the predicted value of 40×10^6 e.v.

H. P. D.

Physical Chemistry of Clays in relation to their Crystalline Nature

Interesting relationships between the crystalline nature of clays and some of their physicochemical properties were pointed out by several contributors to the discussion on clays held on August 22, 1938 at Cambridge under the auspices of the British Association for the Advancement of Science.

Dr Nagelschmidt explained that in Montmorillonite and in similar base exchange clays, the lattice sheets composed of the so-called Si-O-Si and OH-Al-OH layers or planes characteristic of such clays carry considerable negative charges as a result of the isomorphous substitution of Al for Si and Mg for Al and electroneutrality is maintained by cations held by electrostatic forces in water layers separating the successive lattice sheets. These cations are readily exchanged for others carrying the same charge.

Referring to the dependence of the cation exchange capacity of clay on the hydrogen ion concentration of the dispersion medium, Dr R. K. Schofield suggested that in addition to isomorphous substitutions within the lattice there are probably other origins of the charge of clay particles. There are spots on the particles which are charged or uncharged depending on the reaction of the medium. The spots are of two kinds, acidic and basic and capable of holding cations and anions, respectively. While a plausible interpretation of the acidic spots is possible in terms of the lattice structure, the nature of the basic spots is rather obscure. The clay minerals so far known do not appear to contain such basic spots which are, however, frequent in the common clays. Where the positive charge due to the dissociation of the basic spots exceeds the negative charge arising from isomorphous substitutions within the lattice, iso-electric points will be observed.

Observations on the thixotropic properties of clays and some of their 'moisture relationships' in relation to their lattice make-up were made by other contributors.

R. P. M.

Auxin Transport in Plants

The mechanism of polar transport of auxin has recently been explained by Went in his "*Botanische Polaritäts theorie,*" the idea being that the dissociated anion of auxin is transported longitudinally in detail and have demonstrated the apical negativity and the pasal pesitivily of the organ in question, but polar heteroauxin trans port in Avena coleoptiles may be specifically Auxin Transport (*Plant Physiol.* Vol. 12 Nos. 2 and 3, 1937 and Vol. 13, 1938) have studied the question in detail and have demonstrated the apical negativity and the basal positivity of the organ in question, but polar heteroauxin transport in Avena coleoptiles may be specifically abolished by using certain lysins as one part of sodium glycocholate in 100,000 parts of water without there being any change in electrical polarity, respiration, semi-permeability, growth by cell elongation or protoplasmic streaming. Therefore electrical polarity expressed in terms of inherent

potential differences has no apparent causal relation to polar auxin transport. Thus an interesting and promising field is offered for further investigations into the mechanism responsible for polar transport.

B. K. K.

Nitrogen Assimilation by Plants

The mode of assimilation of ammonium nitrogen has been shown to be quite different from that of nitrate in pineapple under green house conditions and in synthetic culture media with ammonium or nitrate salts, by C. . Siders, B. H. Krauss and A. Y. Young who have carried out investigations on Assimilation of Ammonium and Nitrate by Pine-apple Plants grown in Nutrient solutions and its effect on Nitrogenous and Carbohydrate constituents, (*Plant Physiol.* Vol. 13, 1938). Ammonium nitrate was absorbed from the nutrient solution at a greater rate than nitrate and was more rapidly assimilated resulting in greater quantities of total nitrogen, higher amount of chlorophyll and greater tissue succulence. Ammonium nitrate was apparently assimilated in the roots and the immediate products of its assimilation were amino-acids, small quantities of glutamine and asparagine. These products accumulated in great quantities in tissues lacking chlorophyll as in non-chlorophyllous tissues of the leaf bases, while in chlorophyllous tissues they are converted readily into proteins. Nitrate nitrogen was assimilated very slowly in the roots. Most of it was translocated through the stem and non-chlorophyllous tissues of leaf bases presumably to the chlorophyllous tissues where it is converted into protein nitrogen. The amounts of reducing sugars and sucrose were greater in the leaf tissues of the plants with nitrate than with ammonium nutrition.

B. K. K.

Calcium Requirement of Aged Persons

Calcium is now a recognised important essential element in human nutrition. The researches of Orr in Great Britain, of McCarrison in India, of Sherman in U. S. A., of Kung, Yeh and Liu in China and of Rubner in Germany and Japan prove conclusively that large sections of the population of these countries would be more adequately nourished were they to take more calcium. In case of school children it has been found that growth could be enhanced by giving them whole or separated milk. The benefits resulting therefrom, had been proved to be mainly due to the calcium and phosphorus contained therein. Calcium lactate had been found to improve the growth rate of Indian school children. During the last world war, "Hunger Osteomalacia," a nutritional disease of the skeleton became very prevalent in Germany and Austria. This was clearly the result of a widespread lack of calcium and phosphorus. This disease which was more prevalent amongst elderly people was diagnosed as Osteoporosis Meulengracht and Meyer after careful investigation proved that senile Osteoporosis was the result of long standing calcium deficiency.

In order to determine the effects of a long standing deficiency of calcium it is first necessary to determine the calcium requirement of older subjects. A decrease of requirements with age would of course offset, to some extent, the effects of low intake. It is also of importance to find out whether, after depletion of these elements, the older organisms will store additional Ca and P, in the same way as the young adult.

E. C. Owen (*Biochem. J.* **33**, 22, 1939) describes experiments which throw light on this point. The experiments were carried out with ten subjects mostly old or of middle ages. A preliminary period on a low calcium diet was followed by one on a higher intake. The duplicate diets were analysed for total Ca and P in three day lots. Urine and faeces were similarly analysed every three days. From these experiments it is found that Ca and P equlibrium may be attained with 520 mg. Ca and 12,00 mg. P per day. It is also proved that calcium requirement of older males are much the same as those of younger adults, so that the effect of long subjection to a diet low in calcium is not offset by increasing age. The older organism resembles the young adult in that it readily retains Ca and P after depletion.

H. N. B.

UNIVERSITY AND ACADEMY NEWS

PROCEEDINGS AND PUBLICATIONS

National Institute of Sciences of India

(*Calcutta, December, Proc. Nat. Inst. Sc. Ind. 4*, p. 253-484, 1938)

L. L. FERMOR: Notes on vredenburgite (with devadite) and on sitaparite.

N. N. CHOPRA: The role of nitrogen compounds in the fermentation of fruit juices.

S. C. PILLAI: A biochemical investigation of the tuberculation of water pipes.

M. N. SAHA AND R. N. RAI: On the ionization of the upper atmosphere.

S. M. SULAIMAN: Levi-Civita's formulae for two bodies.

H. G. MOHAMMAD: The variation of sound absorption coefficient with intensity.

B. N. SRIVASTAVA: Heat of ionic dissociation of iodides of rubidium and lithium and electron affinity of iodine.

D. N. WADIA: The Post tertiary hydrography of Northern India and the changes in the courses of the rivers during the last geological epoch.

S. L. HORA: Changes in the drainage of India, as evidenced by the distribution of freshwater fishes.

G. LACEY: The flow of water in alluvial channels.

C. C. INGLIS: The uses of models for elucidating flow problems based on experience gained in carrying out model experiments at the Hydrodynamic Research Station, Poona.

S. C. MAJUMDAR: River problems in Bengal.

N. K. BOSE: River physics laboratories of Europe and America.

Symposium on River Physics.

Society of Biological Chemists, Indian

(*Bangalore, 18th February, 1939*)

G. NARASIMHA MURTHY: Electrical mobilities of red blood corpuscles in laboratory animals during malnutrition.

V. V. S. MURTHY AND Y. V. S. RAU: Calcium and phosphorus availabilities in rice.

P. M. N. NAIDU: The test tube chick.

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Book Review

THE EVOLUTION OF PHYSICS—*by A. Einstein and L. Infeld. Cambridge University Press, 1938, pp. X + 313. Price 8s. 6d.*

The book contains a simple and lucid presentation of the main development of the fundamental ideas in the domain of mechanics and physics since the age of Galileo and Newton. It begins with Newton's laws of motion, the law of gravitation and the identification of inertial and gravitational masses. The kinetic theory of gases and the conservation laws are then developed. Theories of electricity and magnetism are next presented, beginning with the earliest fluid theories and ending in Maxwell's electro-magnetic equations. The whole development up to this stage is characterized as a consequence of the mechanical view of matter and energy. Then come the special and the general Relativity Theory, followed by Quantum Theory and wave machanics. The perusal of the book creates the impression of a whole library squeezed into a match-box.

The simplicity of language is almost incredible. The law of inverse square, for instance, is explained without the words, law, inverse and square. It is described as a force between two bodies which increases four times if the distance between them is halved. This simplicity of language, as might be expected, could not be maintained at later stages, where we find, for instance, that ' classical mechanics must change in order to conform with the demand of invariance with respect to Lorentz transformation', or that ' the energy of a light quantum belonging to a homogeneous colour decreases proportionally as the wavelength increases.' In any case, the language is as simple as it could possibly be and there is not a single mathematical formula in the whole book.

About one-third of the book is occupied with the Theory of Relativity. A little more space for Quantum Theory and wave mechanics would be welcome.

The printing and get-up of the book is excellent. No printing mistakes were noticed except the omission of an ' s ' on page 54, line 13.

J. G.

CATTLE FODDER AND HUMAN NUTRITION—*by A. L. Virtanen. Cambridge University Press, pp. 108. Price 7s. 6d.*

This book is based on a number of lectures which the author delivered at the Universities of London and Reading. The first chapter deals with the author's work on the mechanism of biological nitrogen fixation and proof is adduced in favour of the hypothesis that the symbiosis between the host plant and the legume bacteria is a supply of oxalacetic acid by the plant and the conversion of the acid into aspartic acid by the legume bacteria with the fixation of atmospheric nitrogen. Part of the aspartic acid produced is absorbed by the host plant whereas the rest is excreted to the soil. This acid together with β alamin produced from it serves to be the symbiotic link between legumes and non-legumes. This furnishes a theoretical basis of the phenomenon which has been exploited from the ancient times in order to enrich the soil.

Leguminous crops play a decisive role in the tendency to make milk production self-supporting. In order to exploit effectively these protein rich crops, an efficient method of preserving these crops is required for it has been found that in ordinary methods of preservations, the succulent crops lose much valuable protein matter as well as the whole of their vitamin contents. The result is evident in

the consequent deterioration of nutrition value of milk produced from cows, fed on such diets. In the last two chapters the author describes an improved yet cheap method of silage production (the A. I. V. process) which entails very little losses in the total nutritive value of the fodder. The consequence of this method on the production of better quality of milk in stall-fed cows and on the general health of the populace is also discussed.

The whole book is written in a clear popular language and is sure to attract the attention of anybody who is interested in improved fodder production and feeding of farm animals. In India, as in elsewhere attention is focussed on the problems of better milk production as the basis of better nutritive prospect for the growing generation and this book gives a practical hint about one of the ways by which such a production can be cheaply effected.

S. N. R.

STELLAR DYNAMICS- *by W. M. Smart, M.A., D.Sc., Cambridge University Press. pp. 440. Price 30s.*

The subject of stellar dynamics is of recent origin. Since the discovery of star-streaming in 1904 by Kapteyn there has been amazing development of the subject within the short space of thirty-five years, and it is now one of the most important branches of astronomy. Researches of Eddington, Schwarzschild, and Jeans on star-drifts, and the dynamics of stellar systems gave tremendous impetus to the study of the subject and in 1926 Oort made important contribution to our knowledge by his investigation on galactic rotation. More recently Brown, Vogt, and Lindblad have made important investigations in galactic dynamics, and have advanced several theories for the explanation of the observed shapes of the spiral nebulae.

The first book written on the kinematical part of the subject is the excellent monograph by Eddington on *Stellar Movements and the Structure of the Universe*, which was published in 1914. This book is now out of date. Later on, 1917, Jeans published his *Problems of Cosmogony and Stellar Dynamics*; and more recently in 1928 he wrote his *Astronomy and Cosmogony*, which is a sequal to his earlier book. In these two books he dealt with the physical state of astronomical matter, the structure of the stars, the dynamics and the origin of the galactic system. But much has happened in the course of the last ten years, and many new facts have recently been brought to light by Shapley, Plaskett, Pearce and other observers. So new books giving full and up to date account of the theoretical and observational development of the subject seemed to be specially called for. Recently B. J. Bok of Harvard College Observatory has published his notes on stellar statistics, and galactic structure and dynamics.

But a comprehensive book giving a complete description and an up-to-date survey of the knowledge we have at present about the structure and the dynamics of stellar systems, is much needed, and Dr Smart's recent book, *Stellar Dynamics*, has gone a long way towards supplying this pressing requirement. Dr Smart is to be congratulated on his achievement in depicting ably and successfully the present knowledge of the stellar systems in simple and lucid language without sacrificing mathematical rigour and scientific accuracy. He has also discussed the various problems in different aspects *viz.*, historical, theoretical and practical. Dr Smart has divided his book into twelve chapters. The first eight chapters are mainly devoted to the discussion, with considerable detail, of the mathematical theories of the star drifts, statistical parallaxes, and stellar statistics. It appears that the treatment of these subjects has been somewhat overdone. These chapters especially those on the solar motion, the ellipsoidal theory, and statistical parallaxes could have been easily condensed without sacrificing any essential matter. Chapter IX deals with different star clusters *viz.*, moving, open, and globular clusters, and Smart's treatment of the subject is quite complete. In chapter X, Dr Smart gives a faithful account of the fundamental work done by Jeans and Eddington on the dynamics of stellar systems.

The last two chapters *viz.*, chapters XI and XII discuss the galactic rotation and the dynamics of the galaxy which are treated from the observational standpoint; and some recent researches are also included in them. These two chapters could have been usefully expanded by incorporating fuller discussion, from the theoretical standpoint, of the

problems dealt therein, and also by including a brief survey of the present position of cosmogony. Recently the structure of spiral nebulae has engaged the attention of the astronomers and they are trying to find out a satisfactory explanation of the observed shapes of these nebulae. An additional chapter dealing with the different theories of the spiral structure would have increased the utility of this book.

The printing and the get-up of the book are excellent. Unfortunately a few misprints have crept in and some of these are mentioned below. It is hoped that in the second edition of the book these misprints will be corrected.

(1) On page 46, sec. 2.44, we should have B dR instead of n dR

(2) On page 48, in the formula (16) we should have R_2 instead of R.

(3) On page 122, in the 5th and 6th lines from the bottom, we should have '*Observed*' instead of '*Theoretical*'

(4) On page 147, in the fourth line from the bottom, we should have '*270°*' instead of '*180°*'

A. C. B.

NITROGEN FIXATION AND ALKALI SOIL RECLAMATION (Lucknow University Series No. IX)—*by Professor N. R. Dhar, The University of Lucknow, pp. 42. Price not stated.*

The pamphlet is based on an evening lecture delivered by Dr N. R. Dhar at the Lucknow University under the auspices of the Faculty of Science of the Lucknow University. It gives a summary of the work in this line of Dhar and his co-workers who have been successful in inducing an endothermal reaction $N_2 + O_2 + 43.2$ Cal. $2\ NO$ by the energy obtained from the oxidation of different carbohydrates by air. This nitrogen fixation in sunlight is practically double of that obtained in the dark per gram of the energy material oxidised. Their results also show that with cowdung as an energy material the nitrogen fixation in the fields receiving sunlight is much greater than in the dark, when compared per gram of carbon oxidation. Determination of the numbers of azotobacter in soils containing energy materials and the amount of nitrogen fixed in the light and in the dark show that the number of azotobacter per gram of soil kept in light is much smaller than in the soil kept in the dark, although the nitrogen fixation in light is much greater than in the dark. Moreover, when soil mixed with carbohydrates, glycerol etc., comes in contact with air, the carbon decreases and the total and ammonical nitrogen increase by nitrogen fixation. By light absorption, all these processes, are accelerated and hence more nitrogen fixation per gram of energy material oxidised is observed in light.

In an extension of their work in this line Dhar and co-workers have shown that for the reclamation of alkali soils of the dry tracts of Northern India and Mysore, molasses can be very usefully applied. Molasses contain between 60 to 70 p.c. carbohydrates, 4 to 5 per cent potash, 2 p.c. lime, 0.5 p.c. phosphoric acid, 0.5 p.c. iron and aluminium oxides and 0.5 p.c. combined nitrogen and the rest water. Investigations in Allahabad, Bangalore, Java, Hawaii and other sugar producing countries show that when molasses is added to the soil along with carbonic acid, organic acids, like acetic, propionic, burtyric, lactic etc., are produced in the early stage in the decomposition and partial oxidation of the carbohydrates present in the molasses. Consequently, the acids present in the molasses and those obtained from the decomposition and partial oxidation can neutralise the alkali of the soils. Also in the process of the escape of carbonic acid from the molassed soil, the latter is rendered porous and its tilth is improved. The lime which is added to the soil along with the molasses is rendered soluble by the organic acids formed from molasses, and is helpful in the conversion of the sodium soil into the calcium one quickly. The reclaiming effect of molasses is much quicker than that of gypsum or powdered sulphur. Also press-mud which is available in large quantities in sugar factories, containing calcium compounds, carbohydrates and nitrogenous substances, has been found to be an excellent reclaiming agent for alkaline soils. It is interesting to note in this connection, that using one ton of molasses per acre, the Mysore Government obtained 1200-1800 lbs of rice grain per acre of alkali land, whereas the crop failed completely in previous years. Very bad Usar soils have also been

reclaimed and excellent rice crop has been obtained at Soraon (near Allahabad), Government Farms. at Unao, Cawnpore, Shahjehanpur and at Behar.

The interest of this work is both theoretical and practical. First, it suggests that photochemical fixation of nitrogen plays a very important part in tropical soils and secondly, as a practical application of this conception, Dhar has shown that alkali soils can be reclaimed by the addition of cheap energy-rich materials like molasses and press-mud which are at present practically waste products in India. It may truly be said that Dhar has attacked a very fundamental problem of Indian agriculture *viz.*, the supply of cheap plant nutrients to the soil, suitable for Indian conditions. And if, his contentions are proved to be generally true, it will mark a great step forward in the improvement of Indian agriculture, and at the same time it would give stimulus to Indian sugar industry for finding uses of molasses and press-mud which have been so long regarded entirely as waste materials. The pamphlet will prove very useful to advanced students of agricultural chemistry.

S. P. R. C.

A Symposium on Problems of Power Supply in India. *Published by the Council, National Academy of Sciences, India, Allahabad; 1938. Price Rs. 2 (India); Rs. 2/8 (Foreign).*

A country which wants to progress industrially must have cheap and abundant supply of power. This simple fact, self evident as it is, was for a long time not realised in India. Leaving aside the particular section of the politicians who along with the Government administrators of old school, declare from time to time that India had been and always will remain predominantly agricultural, we find with suprise that even that larger and thoughtful section of the people who want the country to be industrialised, and, who ought to know better, have paid till now practically no attention to the fact that the basic thing necessary for the industries to foster is cheap power. It is pleasant to note, however, that this apathy on the part both of the administrators and also of the public is going to be a thing of the past. We find indications that men who are leaders in political throught, in industries and also in science have begun to seriously consider how best the natural power resources of India may be harnessed for the benefit of her teeming millions. The Government of Behar has already moved in the matter and is taking steps for the electrification of the southern part of the province. The Government of Bengal has also appointed an Industrial Survey Committee which, we understand, is busying itself in preparing a scheme for electrification of the western part of Bengal. It is very important that such schemes promoted by the State should be made available to the public in order that they may be intelligently criticised so that the Government, though well meaning, might not unwittingly be involved in an uneconomical scheme such as the Mundi Hydro-electric, of the Punjab. We are, therefore, very pleased to have before us in the form of a brochure an account of the Symposium on Problems of Power Supply in India, held under the auspices of the National Academy of Sciences of India, Allahabad. The publication is welcome for more than one reason. In the first place, it shows that the scientists of our country have come out of their cloistered seclusion in the laboratories to advise and help the industrial regeneration of the country, and secondly the publication serves as an intelligent man's guide to electricity as applied to industry with facts, figures and references regarding the state of electric power supply not only in India but also in other countries like England, United States, Germany and Soviet Russia. A comparative study of the power supply in these various countries at once shows how backward India is in this respect. We note for instance that while the consumption of electricity per capita in such a backward country as Mexico is 120 units per year, that in India is only 7 units. We further note that Canada has the highest consumption in the world with Sweden as second (1100 units). England's consumption was 600 units per capita in 1935 and this is nearly double of what it had been in 1926. This remarkable increase in consumption of electricity in England is due to the inauguration of the Grid Scheme and the setting up of the Central Electricity Board with such powers as enabled it to effect "partial subordination of vested interests to that of the national interest." As a result of the activities of the Board not only the consumption of power, has been doubled but also the average price reduced to half.

The symposium was opened by Prof. M. N. Saha, who summarised the root cause of the poverty problem in India in the following words: "The total output of work per capita per year in India is only 90 units, of which the major part is from manual labour, and only 7 units are from electrical power derived from coal or running water, while in the advanced countries of the west, the total output is nearly 1800 units, of which not more than 60 units are from manual labour, and the rest is all derived from forces of Nature."

The opening address was followed by papers by A. N. Tandon, N. N. Godbole and G. R. Toshniwal who dealt with the problem of electric supply in the United Provinces, in Japan and in Soviet Russia respectively. We read with interest a criticism of the Upper Ganges Hydro-electric Scheme due to Sir William Stampe by Dr Tandon which should be borne in mind by those who are promoting schemes for supplying electricity to the agriculturists. Such a scheme in order to be successful must not only have agricultural load which consumes the power only in certain parts of the year, but also a large industrial load. It is essential that the agricultural load can, from its very nature, form only a small fraction of the former. There are also papers full of informative facts and figures, one by Prof. B. C. Chatterji of Benares, one by Prof. Adarkar of Allahabad who stresses on the necessity of beneficient legislation in India and another by Dr N. G. Chatterjee on power alcohol. The last-named paper is particularly interesting as it discusses the possibility of utilising molasses for the manufacture of power alcohol, which can replace petrol.

Finally we note with satisfaction that the organisers of the symposium were able not only to gather together a number of scientific men and specialists of repute but were also able to induce Pandit Jawaharlal Nehru to preside over their deliberations. As a practical politician Pandit Jawaharlal insisted that before the Government can undertake any comprehensive scheme it must have the suggestions put before it in concrete form. As a result of this the National Academy of Sciences passed a number of resolutions urging upon the Government the necessity of undertaking a survey of natural power resources existing in the United Provinces and also recommending that necessary legislation be passed for nationalization of electricity.

S. K. M

Letters to the Editor

[The Editor is not responsible for the views expressed in the Letters.]

Effect of Transverse Magnetic Field on the Refractive Index and Conductivity of Ionized Air at Ultra High Frequencies

In the course of our investigations on the effect of magnetic field on the refractive index and conductivity of ionized air we have recently published our results with the applied longitudinal magnetic field.[1,2] In the present note we submit the results of similar investigations when transverse magnetic field is applied to the ionized air.

The experimental arrangement was essentially the same as adopted in our previous investigations. The ionized air was contained in a discharge tube about 75 cm. long and 3 cm. in diameter and was made of Pyrex glass. The transverse magnetic field for the whole length of the tube was obtained by a specially designed electromagnet, the section of which is shown in fig. 1. N and S represent the two pole pieces of the electromagnet and T is the section of the discharge tube. The Lecher wires running along the length of the tube are indicated by LL. The length of the electromagnet was made fairly larger than that of the discharge tube so that the whole length of the tube might be immersed well within the uniform magnetic field.

The new expressions for square of the refractive index and conductivity of ionized gas in the presence of transverse magnetic field were deduced from Appleton-Hartree equations without making any approximations. According to the views of Darwin,[3] the Lorentz polarization term was neglected as in the previous experiments with longitudinal magnetic field.

The square of the refractive index and conductivity of ionized gas for the 'extraordinary' wave are given by the following expressions,

where, $p_0^2 = \dfrac{4\pi Ne^2}{m}$

p = angular frequency of the wave,

$p_t = H_t e/mc$, H_t being the applied transverse magnetic field,

and ν = collisional frequency of electrons per second. The rest have the usual notations.

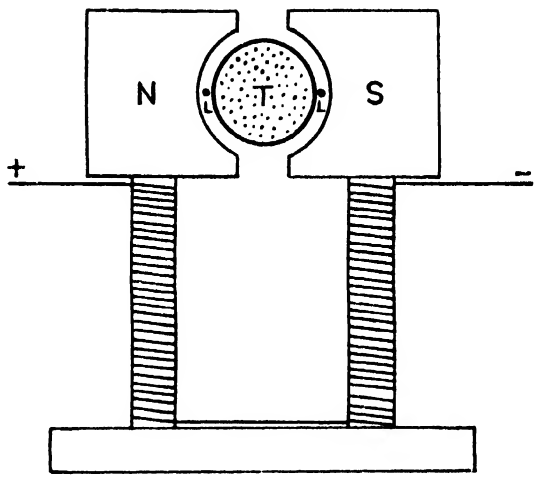

Fig. 1.

$$\mu^2 = \frac{1}{2}\left[1 - \frac{p_0^2\{p^4(p^2-p_t^2) - p^2p_0^2(2p^2-p_t^2) + p^2(p_0^4+p^2\nu^2)\}}{\{p^4(p^2-p_t^2) - 2p_0^2p^4(p^2-p_t^2) + p^4\nu^2(p^2+2p_t^2) + p^2(p^2+\nu^2)(p_0^4+p^2\nu^2) - 2p_0^2p^4\nu^2\}} + \sqrt{1 + \frac{p_0^2\{2p^2p_0^2(2p^2-p_t^2) - 2p^4(p^2-p_t^2) + p_t^4p^2 + p_0^4 + p^4p_0^2 - 2p^4\nu^2 + p^2p_0^2\nu^2\}}{\{p^4(p^2-p_t^2) - 2p_0^2p^4(p^2-p_t^2) + p^4\nu^2(p^2+2p_t^2) + p^2(p^2+\nu^2)(p_0^4+p^2\nu^2) - 2p_0^2p^4\nu^2\}}}\;\right]$$

and

$$\sigma = \frac{p_0^2\nu\{p^2(p^2+p_t^2) + p_0^4 + p^2\nu^2 - 2p^2p_0^2\}}{4\pi\{p^2(p^2-p_t^2) - 2p^2p_0^2(p^2-p_t^2) + p^2\nu^2(p^2+2p_t^2) + (p^2+\nu^2)(p_0^4+p^2\nu^2) - 2p^2p_0^2\nu^2\}},$$

As there is no effect of the transverse magnetic field on the 'ordinary' wave, the corresponding expressions for the same have not been considered. Curves in fig. 2 represent the variation of square of refractive index of ionized air with the intensity of applied transverse magnetic field. The continuous curve is drawn from the theoretically calculated values obtained

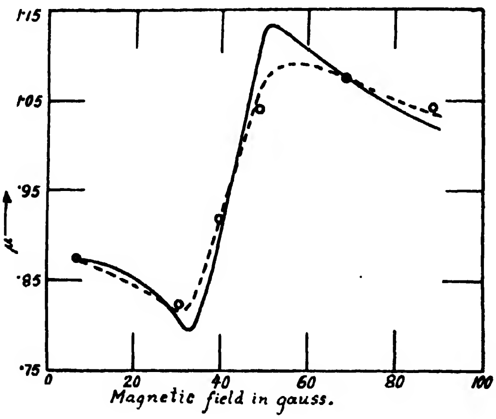

Fig. 2.

from equation (1) for different values of magnetic field and that with broken lines is drawn from the experimentally obtained values. Similar variations of the conductivity with the varying strength of the magnetic field are shown in fig. 3.

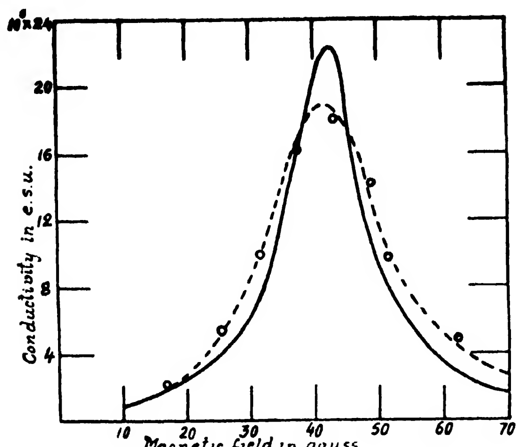

Fig. 3.

It will be noted that these curves are in nature similar to those obtained in the case of longitudinal magnetic field and the collision of the electrons prevents the conductivity and refractive index from attaining infinite values.

It should be added here that in the case of longitutinal magnetic field the conductivity attained it maximum value when the applied magnetic field corresponds to the gyro-frequency value of the impressed wave for all values of the collisional frequency and density of electrons. In the case of transverse magnetic field, however the conductivity of the ionized air does not always reach the maximum value at the gyro-frequency. It is considerably affected by the values of collisional frequency and the density of electrons.

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9-3-39.

S. S. Banerjee.
B. N. Singh.

[1] Banerjee, S. S. and Singh, B. N., *Nature*, *141*, 511, 1938.
[2] Singh, B. N., *Phil. Mag.*, *26*, 244, 1938.
[3] Darwin, C. G., *Proc. Roy. Soc.*, *A 146*, 17, 1934

Disease of Silk worms (Bombix mori. L.)

A serious type of disease causing considerable damage to silk worms (*Bombix mori, L.*) in the Sericultural Research Laboratory, Calcutta was reported. The larva was found dead inside the cocoon when it was cut open, so that the shell could be weighed separately.

An infected larva still alive was brought to our laboratory which died shortly afterwards. The surface of the larva was chalky or lime-like in appearance. The larva gradually lost its elasticity as it died. These dead organisms, sterilised superficially with absolute alcohol, were kept in aseptic condition for a few days. Spores appeared all over the body which gradually turned brown in colour. These spores were found attached to fungal hyphae attacking the whole system of the larva.

Several isolations were taken from living specimens as soon as the disease was detected. Two sets of inoculations were made, one from the surface of the larva and another from the internal organs. Coon's medium was generally used and in the first case two fungi appeared, *e.g.*, *Botrytis bassiana* and *Aspergillus tamarii*, *Kita*, the former in abundance.

In the second series, little bits from the internal organs of the larva were put in culture tube after proper sterilization. Similar fungi appeared but the *Aspergillus tamarii*, *Kita*, was predominant in this case. A similar disease called *Mascardine* was reported from Italy, India, etc., which appeared in the adult caterpillars. The Italian name *Calcino* and the Bengali name *Chuna Kete* were the descriptive terms applied to this disease and the causal organisms were found to be two species of *Botrytis*, *e.g.*, *B. bassiana* and *B. tenella* But in this case the silk worms are being attacked in the larva stage and a species of *Aspergillus* is found to be associated with *Botrytis*. The symptoms also do not tally with those of *Mascardine* in all respects.

Aspergillus fulvus Montagne, has been reported from silk worms from Southern France; but its description is very inadequate and varies from that of the *Aspergillus* isolated b

us. The characters of this *Aspergillus* correspond exactly to those of *Aspergillus tamarii, Kita*, described by Thom, so it has been given the same name.

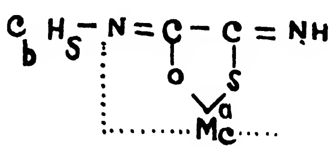
Actual inoculation experiment to induce artificial infection in the larva and finally to find out the exact pathogen, has not been carried out. The work is still in progress and the result will be published subsequently.

Plant Pathology Section, Botany Laboratory, University College of Science, Calcutta, 9-2-39.

Tareshcharan Roy.

Oxanilic Acid Thioamide (C_6H_5 NH CO CS NH_2) as an Analytical Reagent

Oxanilic Acid Thioamide has been observed to precipitate copper (cupric), cobalt(ous), mercury(ic) and nickel quantitatively from sodium acetate—acetic acid solutions. The complexes are of the general formula $M^{II}_{e}(C_8H_6N_2OS)$, whose structure is tentatively given as



with one molecule of water of hydration for the cupric complex. The nature of the precipitates obtained by the addition of the reagent to the respective cations in solutions not containing mineral acids is described below:

Cupric, Cobaltous, Nickelous — brown, granular ppt., quantitative.

Silver, Lead, Gold — Ppt. decomposes to sulphide.

Mercuric—Yellow, granular, heavy ppt., quantitative. Mercurous salts give a heavy yellow ppt. which slowly changes to grey, forming metallic mercury.

Estimations of some of these cations and their separations from other elements are in progress.

Anil Kumar Mazumdar.

Chemical Laboratory, University College of Science, Calcutta, 7-3-39.

The Isomers of 1-Carboxy-4-, 3- and 2-methylcyclohexane 1-succinic Acids

In view of the recent publication of Desai, Hunter and Saharia[1] it is necessary to record that the author, in continuation of the work described in his previous communications,[2] has separated the following isomers of 4,- 3, and 2-methyl cyclohexane 1-succinic acids.

	M.P.
1 Carboxy 4 methyl cyclohexane-1-succinic acid	206°, 176°
1 Carboxy 3-methyl cyclohexane-1 succinic acid	210°, 173°
1-Carboxy 2 methyl cyclohexane-1-succinic acid	194°, 176°

The author fails to understand why Desai, Hunter and Saharia remarks "In the 3-and 2-methyl cyclohexane series he obtained gums" though no such statement was recorded by the author either in SCIENCE AND CULTURE or in the *Journal of the Indian Chemical Society*. Desai, Hunter and Saharia seem to have overlooked the important statement, "no definite isomers of the acids have been isolated and experiments are in progress to separate them" and it may be pointed out that they have repeated the data already published by the author two years back.

Nripendra Nath Chatterjee.

Chemical Laboratory, University College of Science and Technology, Calcutta, 10-3-39.

[1] *Jour. Chem. Soc.* 84, 1939.

[2] SCIENCE AND CULTURE, *1*, 788, 1936 and *Jour. Ind. Chem. Soc.*, 127, 1937.

Gallium in Indian Bauxites

Gallium has been reported to be present in bauxites. With this view several samples of Indian bauxites from different localities were examined for this rarer element. Gallium was concentrated with arsenic in the second group and then arsenic was eliminated from the hydrochloric acid solution after dissolving the mixed sulphides in aqua regia.

The concentrated hydrochloric acid solution was examined spectroscopically with the help of Hilger E. Spectrograph using carbon arc. The characteristic lines 2874.2,2943.6,2944.2 Å have been observed in the spectra. The spectrograph was adjusted so that the spectrum contained the lines about 2475 to 4390 Å. More samples of bauxites are being examined.

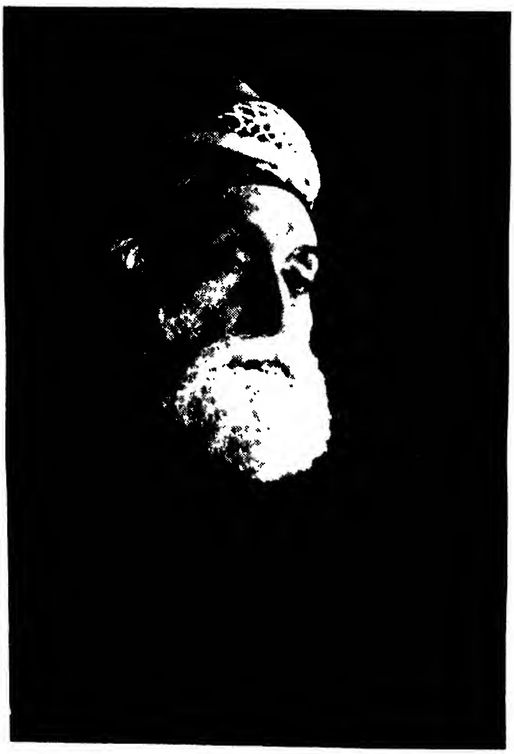
Details of the experiments will be published elsewhere.

Chemistry Laboratory, University College of Science, Calcutta, 10-3-39.

Jyotirmoy Das Gupta.

Jamsetji Nusserwanji Tata

The 3rd of March, 1939, was the centenary of the birth of Jamsetji Nusserwanji Tata. His memorials are spread all over India the great mills at Nagpur, Ahmedabad and Kerla, the Indian Institute of Science at Bangalore, the flourishing town of Jamshedpur and the submerged velleys of the Western Ghats with the hydro electric enterprises which have transformed the city of Bombay, but the greatest of these all is the firm of Tatas which have been the pioneers in many fields of economic regeneration and industrial development in India. It is but in the fitness of things that his centenary should have been celebrated in many parts of India culminating in the imposing ceremony recently held at Jamshedpur.



Jamsetji Nusserwanji Tata

The accidents of education or of environment in early youth can claim very little influence in the shaping of this great personality whose genius transcended all barriers and created vast enterprises and wide opportunities for service to motherland. His father in the early youth broke away from the proverbial family tradition of ascetism (the Tatas were originally high priests of Zoroastrianism) and established the firm of Nusserwanji and Kalyandas. Jamsetji was educated at the Elphinstone college, Bombay and after a short apprenticeship in a solicitor's office proceeded to China to look after his father's business there. The boom in the export trade of cotton during the American Civil War and the subsequent collapse due to over-speculation in which his father's firm was deeply involved tested the mettle of young Jamsetji. At the instance of Premchand Roychand (founder of the famous Premchand Roychand studentship at Calcutta), he was in England looking after the cotton consignments there when the crash came. He met his creditors and so impressed them with his business ability and honesty that they appointed him the liquidator of the firm which he represented. His stay in England and frequent visits to Manchester gave him expert knowledge of the process of cotton manufacture and deep insight into the cotton trade as conducted in the Western countries. Father and son soon rehabilitated their fortunes by securing the contract for commissariat at the expedition to Abyssinia under Napier which cost the public exchequer some one hundred and thirty million rupees. With the profits of the Abyssinian campaign, Jamsetji purchased an oil mill at Chinchpoogly which was converted into a cotton mill with the aid of some partners and later on sold off at a considerable profit.

Cotton mills were then successful ventures in Bombay, but young Tata found no pleasure in following the beaten track. He early foresaw that the profits of a manufacturing enterprise depended on the ready access to cheap raw materials and to a consuming market. And Nagpur appeared to him to be an excellent site for the location of cotton mills from every point of view. The idea was ridiculed by many but Jamsetji knew his business. The Empress Mills at Nagpur which have systematically paid higher dividends than similar enterprises elsewhere in India, not only earned for him great reputation as a captain of industry but created in him a stubborn self-confidence and an

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Need of Calendar Reform

THE calendar is an indispensable requisite of modern civilised life. It is a table of the days of of the year, divided into months and weeks, and showing the chief holidays, and festivals, religious as well as national. We are guided throughout the year in our activities by the calendar which we keep suspended either on the wall, or on our table for ready reference.

But calendars are almost as numerous as nations. At the present times almost the whole of Europe uses the Gregorian calendar* for economic as well as for religious purposes, and in other parts of the world, the Gregorian calendar has spread along with European domination. But most of the Eastern countries excepting Japan and China retains, at least for religious purpose, indigenous systems of calendar, which very often clash with the official calendar and produce serious dislocation of public work.

*So called after Pope Gregory XIII, who introduced the present system of calendar-reckoning in 1582.

Even the Gregorian calendar is unsatisfactory and to some extent arbitrary. The months are of unequal duration as expressed in the well-known doggerel,

Thirty days hath September,
April, June and November,
All the rest hath thirty-one,
Excepting February alone,
Which has twenty eight,
And twenty-nine in each leapyear.

One may ask why is there this arbitrariness. Why has February 28 days, while other months have 30 or 31 days? But more serious is the inconvenience caused by the wandering of some important holidays. Thus the Easter Festival may fall on any date between March 22, and April 25, a total amplitude of 35 days. Now Easter is a pivotal holiday and many others move with it. This periodic wandering of the Easter and associated holidays produces general inconvenience, and dislocation of public and private work. Further, the

cycle of week repeats in an arbitrary way throughout the month, and there is no knowing, on *â priori* ground, with what day of the week the year or the month is to begin.

The League of Nations has appointed a World Calendar Reform Committee for a rational reform of the calendar. But unfortunately for the Committee, the nations composing the League have shown themselves too conservative, and there appears at present no likelihood of the World Calendar being accepted, and replacing the old calendar even in the most advanced countries. However much the reformers may regret this decision, they have not lost heart, but are continuing the agitation with the unabated zeal of the man who feels that he is backing a righteous cause!

Our opinion is that the proposals for calendar reform do not go far enough. Further, they do not consider the Eastern nations at all. We think that the beginning of the year should be fixed up at some definite astronomical event, say the vernal equinox (as the Iranians have done since the eleventh century) or at winter solstice. In fact, the Christian year originally began with the winter solstice, and the present fixing of New Years' Day on January 1, is due to blunders committed in medieval times. There is no reason why this error should be retained.

Besides the Gregorian calendar, which is used throughout India for official purpose, the Indian people have to use others, each with its definite religious stamp. The Mahomedan calendar is, as is well-known, entirely lunar, and consists of 354 days, so that the Mahomedan religious year wanders throughout the civil year, making a complete cycle in about 33 years. But human life is more dependent upon the sun than on the moon, and many enlightened Mahomedan rulers saw the necessity of using the solar calendar at least for administrative purpose. We mentioned the case of Persia earlier, and in India, Akbar introduced the solar calendar for official use.

The Hindu calendar which regulates the life of 99% of the 250 millions of Hindus, is a most bewildering production of the human mind, and incorporates all the superstitions and half-truths of medieval times. In theory it uses the sidereal year, the length of the year being still taken as 365.25875648 days as fixed up by Aryabhata about 505 A. D., under the mistaken impression that the equinoctial points did not precess, but merely oscillated. The real length of the tropical year is 365.24219879 days, so that the Hindu civil year exceeds the correct length by 0.01656 day nearly. The result is that the solar months, which were definitely linked with stars, are revolving throughout the seasons; and the beginning of the year is now wrong by nearly twenty-three days, the result of accumulated error of nearly 1400 years. The Hindu calendar describes April 15, as the day of the vernal equinox, but as is well-known this event actually falls on March 21. If the error is allowed to accumulate, the months will describe a complete cycle round the year in about 23000 years. Further, as the festivals are connected to the moon, the season and the stars, the dates have to be adjusted periodically by an intricate system of intercalation. In spite of these errors, very few have the courage to talk of reform. We are content to allow religious life to be regulated by the encyclopoedia of 'errors and superstitions' which is called the Hindu almanac, and to regard it as a scripture.

Elsewhere in these pages, we give a review of the schemes of the reformed World Calendar, and a short account of the origin of the Gregorian calendar. The Hindu calendar will receive detailed attention in a subsequent issue.

The Reformed Calendars and The Gregorian Calendar

THE two best known movements for calendar reform are (*a*) the thirteen-month calendar and (*b*) the reformed twelve-month calendar.

Thirteen-month Calendar

In the thirteen-month calendar there are to be 13 months in the year, each of 4 weeks and each week of 7 days. Every month is to begin with a Sunday and end in a Saturday. This calendar is extremely simple compared with the present system where January might begin with a Sunday but February may begin with Tuesday and so on. According to this reformed scheme, the regular year will consist of 354 days, but as the actual year is nearly 365¼ days, it is proposed in the 13-month-calendar system that in an ordinary year, the last day will be an *extra day* and will be called a second extra Saturday. For the leap year it is proposed to have two extra Saturdays, one at the end of December and the other at the end of July.

All years alike

All months alike

Every month begins with Sunday and ends with Saturday.

S	M	T	W	Th	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28

1 Month = 4 weeks = 28 days.

1 Year = 13 months = 28 × 13 = 364 days.

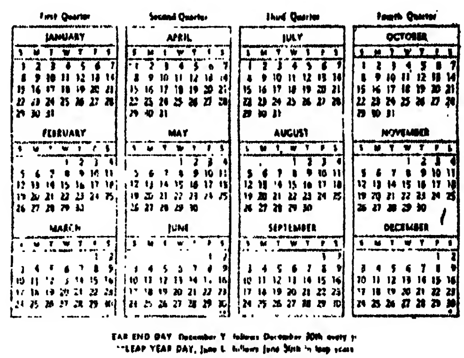
One extra Saturday at the end of the year (Year End Day))

Two extra Saturdays in Leap years (Year End Day, and Leap Year Day).

The idea of stabilising the calendar in the above way was suggested to the Vatican by an Italian Padré Abbé Mastrofini, in 1834 and the idea was revived by the positivist philosopher, August Comte in 1849. He wanted to rename the months after the great men of the world.

The Reformed Twelve-month Calendar

The other system for calendar reform retains the twelve months as shown below.



" This World Calendar is a revision of the present calendar to correct its inequalities and discrepancies. It rearranges the length of the 12 months so that they are regular, making the year divisible into equal halves and quarters in a "*perpetual*" calendar. Every year is the same; every quarter identical.

In this new calendar, each quarter contains exactly three months, 13 weeks, 91 days. Each quarter begins on Sunday and ends on Saturday.

REFORMED CALENDARS AND GREGORIAN CALENDAR

The first month in each quarter has 31 days, and the other two 30 days each. Each month has 26 week-days.

In order to make the calendar perpetual, at the same time retaining astronomical accuracy, the 365th day of the year, called Year-End Day, is an intercalary day placed between December 30th and January 1st and is considered an extra Saturday. The 366th day in leap year, called Leap-Year Day, is intercalated between June 30th and July 1st on another extra Saturday. These intercalary or stabilizing days are tabulated as December 31 or Y and June 31 or L, and would probably be observed as international holidays. January 1st, New Year's Day, always falls on Sunday.

The revised calendar is balanced in structure, perpetual in form, harmonious in arrangement. It conforms to the solar year of 365.2422 days and to the natural seasons. Besides its advantages in economy and efficiency, it facilitates statistical comparisons, co-ordinates the different time-periods, and stabilizes religious and secular holidays when approved by their respective authorities. As compared with any other proposal for calendar revision, it offers an adjustment in which the transition from the old to the new order can be made with a minimum of disturbance." (From *Journal of Calendar Reform*).

The supporters of the world calendar reform publish a journal called *World Calendar Reform* and through the League of Nations they are trying to advocate the adoption of the reformed calendar throughout the world. But the thirteen month calendar appears to have been given up, due to the unpopularity of the number 13 and due to some astronomical objections. But the twelve-month calendar is being advocated for adoption by the League of Nations.

Units of Time

Let us see what is the root cause of this dissatisfaction with the present calendar. In human life we are most directly concerned with the day and the year and, to a lesser extent, the month. The day is determined by the period of the earth's rotation about its axis or return of the sun from the zenith to the zenith or from nadir to the nadir. The day-and-night phenomenon completely controls all human activity. Further, the day is the fundamental unit of time and every other unit is to be measured in its terms.

Amongst ancient nations, however, the day was not so precisely defined. Some ancient nations like the Indians measured the day from sunrise to sunrise, others like the Jews and the Greeks before 400 B.C., from dusk to dusk. The day measured in this way will have varying lengths during the year and, therefore, has been universally given up. At the present time, the day begins at midnight when the sun is at the nadir and we reckon from zero hour to 12 noon when the sun is at the zenith and after 12 noon as 1 p.m. to 12 p.m. till it is again midnight. In America and on the continental railways, however, neither a.m. nor p.m. is used but it is customary to measure from 0 to 24 hours.

The day defined in this way is still somewhat variable in its length and we use as a fundamental unit of time what is known as the mean solar day.

In Hindu system, the astronomical day was fixed as beginning from midnight at Ujjayini or Lanka from the time of Aryabhata I (499 A.D.). It should be remembered that the astronomer's Lanka is a hypothetical city, supposed to be on the equator, and on the same meridian as Ujjain. (*Cf. Dasagitika* 2, *Gola* 13 and 14; *Pancasiddhantika*, *XV*, 20).

The Week

The cycle of 7 days called the week is an entirely artificial cycle, *i.e.*, unlike the natural periods of time—the month, the year and the day- it has got no reference to any astronomical phenomenon. It depends upon the ancient Babylonian superstition that the number 7 had some magical meaning as it corresponded to the number of heavenly bodies which are in motion, namely the sun, the moon and the five planets, Mercury, Mars, Jupiter, Venus and Saturn. This led the Babylonians about 1800 B.C. to invent the cycle of seven days, each day after a planetary god. The seventh day was originally considered as an unholy day. But when the Jews took up the Chaldean calendar about 600 B.C., they called it the Lord's day, and invented the myth that

REFORMED CALENDARS AND GREGORIAN CALENDAR

God rested after His labour of Creation on the seventh day, the Sabbath. According to Jewish scriptures, all work was prohibited on the seventh day. But many ancient nations including the Hindus had originally no such cycle as the week. It appears to have come into vogue in India with the Macedonian Greeks (who got it from Babylon about the first century A.D.) The Romans divided their month into sections ending in Calends (new moon), Nones (eighth day) and Ides (full moon) but from 325 A.D., the use of the week became common throughout the Roman Empire. The Egyptians had a separate name for each day of their month of 30 days. It was divided into three sections, each called a Dekan or Decade. This system of division of the month into 3 smaller units each of ten was revived by the French during the Great Revolution of 1792, when they wanted to do away with everything smacking of religious superstition and went mad after the decimal system. So they invented a week of ten days and a month of three weeks. But the cycle of 7 returned again with the fall of the French Revolution (1804). The experiment was renewed again by the Bolsheviks in Russia who successively toyed with the idea of week of 5 days and 6 days, but ultimately returned to the 7-day week. Probably though the 7th day period has no foundation on any phenomenon of Nature, it may have something to do with the human system as regards endurance, efficiency and the need for rest.

The Month

The other division of the time which is most conspicuous besides the day and the year is the month. This is entirely a lunar phenomenon. Month is really " Moonth " or period of the moon. One can easily observe that the moon which gives us light during the night travels in the heavens amidst the stars very nearly in the same path as the sun. In fact it is inclined to the sun's path at about 5°. But the moon goes round the heavens much quicker. It returns from one point of the sky, say, the star Aldebaran, to the same point in about 27⅓ days. This is known as the ***sidereal month.*** But the real month in use is the period when it returns to its conjunction with the sun. When the sun and the moon are together, the latter is entirely invisible and we have the phenomenon of the new moon. The month, according to all ancient nations extended from the first day after new moon to the next. The length of the *Synodic month* is very nearly 29½ days.

Such ancient nations whose religious beliefs were connected with the moon divided the heavens into 27 to 28 divisions, each of about 13⅓° and called each division a lunar mansion or a *Nakshatra.* But the period of the moon, the month, was reckoned from new moon to new moon and consisted of 29½ days. They observed that 12 months amounted to about 354 days and was very nearly equal to a year.

Inconsistencies in Calculation of Months

The idea that the year should be divided into 12 months must have arisen from the observations of the moon's motion. But if we reckon according to the lunar month, 10·875 days still remain every year after the 12 lunar months are finished. How to adjust this? There was grave reason why this adjustment should have been considered extremely necessary. In the life of early nations religious festival played an extremely important part. A certain incident, say, the worship of a god, was to be celebrated in the season of autumn at full moon. Now, suppose in a certain year, the festival falls on the last day of autumn, next year we shall lose 10·875 days; the event will have to be celebrated 11 days earlier than the end of autumn. Two years later, it is to be celebrated 22 days earlier. In five years the retardation will be very nearly two months and the event will fall not in the season of autumn at all but in the rains. So adjustment is necessary unless we discard the connection with the season entirely as the Mahomedans have done. This the ancients were not prepared to do; they made the adjustment by bringing the event forward by calling two months in five years as unclean or useless months and prohibiting the celebration of the festival within these two months. By this artifice at the end of 5 years, the event will again fall at the end of autumn. Amongst certain nations instead of putting such intercalary or useless months at the end of every 5 years, one intercalary month is put at the

of 31 days. So one more day had to be found out and this was done at the expense of unfortunate February, whose length was thus reduced to 28 days. In a leap year, February was given a length of 29 days. This is the origin of the Julian calendar, which was used throughout the whole of Europe up to 1582 A.D. It bears the impression of Egyptian science and imperialistic vanity of Rome. But this did not clear away all the confusion. As has been pointed out before, the year is not exactly 365¼ days, but somewhat smaller. In course of centuries, this error had accumulated and produced a confusion. The total error amounted to about 9 days, in 1577, when Pope Gregory XIII called a conference of astronomers and asked them to correct the calendar. They recommended that though normally a year which can be divided by 4 should be called a leap year, in case of those years which ended in two zeros, only those years should be regarded as leap years which are divisible by 400. Thus the years 1700, 1800, 1900 are not leap years but 2000 will be a leap year. By this adjustment the mean length of the year was fixed at 365.2425 days and the mistake amounts to three days in 10000 years.

In 1582, the dates were advanced by a decree of the Pope by 9 days. This system, or the Gregorian system as it is called, was adopted throughout the whole of Roman Catholic Europe. But the Protestant countries and those belonging to the Greek Church did not adopt it on account of their antipathy towards the Pope. In England the old Julian calendar was used up to 1752 when public opinion was enlightened enough to tolerate the introduction of the Gregorian calendar. This was done by a special Act of the Parliament and the days were advanced by 11 days. September 22 was by official decree re named as October 4th. This led to some confusion and even to riots, because the man in the street thought that the Government had passed the Act simply to cheat him of 11 days' wages. 'Give us back our 11 days' was a cry long heard amongst the labouring classes of England. In Russia the old calendar was in use even up to 1918 when the Bolshevik revolution swept that away, and adopted the Gregorian calendar.

The Gregorian calendar is now almost in universal use throughout the whole civilised world, but in certain respects it is very unscientific. The months are of unequal length and there is absolutely no justification for this except the alleged vanity on the part of the Roman dictators. The beginning of the year with January 1st is also rather arbitrarily fixed. It ought to have started with the winter solstice day (Dec. 22), or with the vernal equinox (March 21).

The European calendar shows not only the week days distributed during the month but also the days connected with the great events and Church holidays. Most of these have no connection with the moon, excepting the Easter, which is supposed to commemorate Christ's Resurrection on first Sunday following full moon after vernal equinox. The date of the Easter in the Gregorian calendar is thus variable and it can fall on any day between March 20 and April 25, having a total latitude of 35 days. Now Easter is a pivotal holiday, as others move with it. This has been a source of trouble to the methodical European nations but no compromise has been found between religious dogma and the necessities of economic life. The World Calendar to some extent rectifies this inconvenience, as Easter will always fall on April 8. This cuts off the connection with the moon, and the Easter will rarely be celebrated on full moon. But as the day of nativity of Christ (the solstice day) has no connection with the moon, the reformers see no reason why the day of the alleged Resurrection should be tied to the moon. In other ways the World Calendar of 12 months is an almost ideal calendar and, if adopted, will result in great simplification. But though it is ideal from the point of view of economic life, its adoption will depend upon whether all nations can discard their old traditions and superstitions based on religious inheritance, and would be prepared to sacrifice the lunar connection.

We are, in favour with the World Calendar, but we think that the starting point of the year should be from the day of vernal equinox, as is the case with the Iranian calendar, and the months should be renamed according to seasons.*

M. N. S.

* The writer wishes to acknowledge his indebtedness to Prof. P. C. Sengupta for much useful criticism, and part revision of the article.

Oil Development in India

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It has been said that a Chinese traveller who visited Burma in the thirteenth century found the oil industry already established. The Indian oil industry cannot claim any such antiquity; although the seepages of petroleum must have been known for centuries, there is no record of any early attempts to dig wells for petroleum after the manner of the Burmese hand-dug wells. The modern oil industry dates from 1859, when the first American oil wells were drilled by machinery. A little before this some of the oil seepages of the Punjab were attracting attention, and a few years later there were put down shallow borings in Assam and in the Punjab. No success rewarded these early efforts, but a renewal of operations in Assam led to a sustained but very small yield of oil being found in 1890. This encouraged further development, but no prolific wells were obtained, and for a quarter of a ry the total yield of oil in India was extremely

Rather less than thirty years ago the careful scientific prospecting which is so marked a feature of the present-day oil industry was first begun in India, and new oilfields were found in Assam and in the Punjab, but both of these fields turned out to be somewhat disappointing. In Assam, the Badarpur field, proved in 1915, became exhausted after a life of only eighteen years; in the Punjab, the Khaur field, although it has outlasted the Badarpur field, has in recent years declined to a comparatively small output. In the meantime, an active and scientific development policy in Upper Assam has led to a greatly increased yield from that region, whilst very recently the prospecting wells at Dhulian, near Khaur, have proved a new and valuable oilfield.

The search for new oilfields is constantly carried on by the geological staffs of the oil companies. Although oil is a mineral, the mobility which distinguishes it from the rest of the mineral world adds greatly to the difficulties facing the prospector, and the search for it calls for the most up-to-date methods of geological, palaentological, petrological, and geophysical research. Even so, the majority of prospecting wells fail to find oil in commercial quantities, and the prospecting company must be prepared to put down many lakhs of rupees with only a small chance of getting any return.

Of no less importance is the application of scientific method to the development of the oilfield when once it has been proved, beginning with the drilling of the well. The most modern system of drilling, almost exclusively used in India, is capable of penetrating to very great depths; the strata are cut by a rapidly rotating bit (of specially hardened metal) which is carried at the end of a long steel pipe made up of sections some 20-30 feet in length. Through this 'drill-pipe' is pumped a carefully prepared fluid composed mainly of clay and water (often chemically treated to make it suitable for the work it has to do) and this fluid cools and lubricates the bit, and, circulating back to the surface through the annular space outside the pipe, plasters up the sides of the hole and also brings up the pieces of sandstone, shale, etc., cut off by the bit. The well is lined with steel casing, firmly cemented in place in such a way as to prevent the incursion of water.

Drilling to great depths may take many months or even, in exploratory wells, several years, and the ability to pierce the crust of the earth to depths which may greatly exceed a mile (and in exceptional circumstances may even exceed two miles) is one of the triumphs of modern engineering, won only

by the unstinted expenditure of skill, time, and money.

Fig. 1.

A 'Plough' type 'Fishtail' bit used for rotary drilling. Note the flow pipe for mud circulation.

Amongst the difficulties to be overcome are the tendency of some strata to swell and force their way into the hole, exerting a pressure of thousands of pounds per square inch, the occurrence of porous sands containing water under similar high pressures, the steep inclination which the strata may have—which may become a serious difficulty when the drill passes through alternately hard and soft bands. But even when the drilling is comparatively free from troubles of this kind it is an achievement to be able to drill a hole a few inches in diameter to such great depths. The length of the drill-pipe carrying the bit may be 30,000 or 40,000 times its diameter, and its slender proportions may be compared with those of a long delicate hair or even a spider's thread—if we could imagine these having a hole right through their entire length. The manufacture of pipe of these proportions has been made possible only by the recent great improvements in the tensile strength of steel.

For the assistance of the driller there are now a number of sensitive, often self-recording, instruments which can be attached to different parts of the drilling 'rig' to give the driller a better idea of what is happening a mile or more away beneath his feet. These instruments, although sensitive, must be sufficiently sturdy to stand the vibration and wear and tear inseparable from heavy drilling machinery. Then, too, the scientist has developed surveying instruments which can be lowered down the well at intervals to show how much the hole is deviating from the vertical, and other instruments which enable the strata drilled through to be identified from measurements of their electrical properties. What years ago was a rule-of-thumb craft, is now a branch of engineering science.

When the well is completed, the 'production engineer' takes over charge from the driller. At first, the oil in the well may come right up to the level of the ground, but in time, as the underground

Fig. 2.

A well being produced by a 'Cable Tool End' individual pumping unit.

pressure falls off, it is necessary to adopt some means for bringing the oil to the surface. This

may be by insertion of a pump operating far below the well-head, or by system of 'gas lift' which is similar to the air lift sometimes used for water wells. Not only does the pressure fall off, but the rate of production of oil declines, often from the day the well is completed. To keep up the output of an oilfield new wells must be drilled, and this drilling effort is usually continuous from the time the field is discovered until the whole of the productive area has been developed.

The spacing of wells, the order in which they are drilled, and the general scheme of development are matters which should not be left to mere chance, but must be carefully planned out on scientific principles, for the way in which development takes place has an important bearing on the amount of oil which can be obtained from the oil-sands. Development will necessarily be influenced by the circumstances in which oil companies hold their concessions from the owners of the mineral rights, for these have a profound determining effect on the incentive to conservation on the one hand or to wasteful methods on the other.

American oilfields for example were largely developed by a number of operators and mineral owners in unrestricted competition; there was thus a large premium on a 'get there first' policy, each producer trying to obtain his share of the oil as quickly as possible lest in the meantime his neighbour got it, and each mineral owner being concerned only in seeing that *his* oil was brought to the surface and his royalty income realized quickly. As oil, unlike other minerals, is mobile, the principle of 'first come first served' applies to a considerable extent in such competitive drilling. Unfortunately for the resources of an oilfield, development which gives this quick production is not conducive to obtaining the maximum ultimate yield of oil from the sands; in recent years there has been a movement in America to treat each individual oilfield as a unit; the different operators agree to co-operate in developing by methods designed to extract the greatest possible total amount of oil. But private mineral ownership as well as *individual* State control continues to hamper and block such movements.

The case is entirely different where the State itself owns the minerals and one oil producing company has a long lease of a whole oilfield and can count upon continued renewal of its lease provided its work is satisfactory. Its interests then lie in obtaining from the field as much oil as possible over the whole period of its life, so that conservation of the resources of the field becomes as much the interest of the operator as of the owner (*i.e.*, the State).

In British India fortunately the mineral rights in the oilfields are the property of the State, and in no case at present is there any competitive drilling. The operator can therefore plan development so as to obtain the greatest ultimate yield of oil, having no incentive to do otherwise; and this is in fact what he does.

The oil in Assam, as in so many other fields throughout the world, occurs in minute pores and

Fig. 3.
Part of the Digboi Field, looking west.

crevices in sandstones which lie from several hundred to several thousand feet below the earth's surface. In its original state the oil in the sands usually contains a large proportion of natural gas, which, at the pressures prevalent at such great depths below the surface, is either in liquid form or is dissolved in the oil. When a well is drilled into the oilsand, the local release of pressure enables the gas to vaporize and to expand and in so doing it forces some of the oil into the well. If the pressure in the sand is sufficiently great the oil will be brought right up to the surface.

The volume of gas (measured at atmospheric pressure) is often many hundreds of times the

volume of the oil with which it is associated, and if the flow is uncontrolled a spectacular gusher may result. Experience in other parts of the world has, however, shown that if a well flows in this wild fashion, the gas tends to come to the surface without bringing with it the full amount of oil which would be obtained if production were controlled at the well-head. Accordingly the best modern practice, which is carefully followed in the Indian oilfields, is to take every precaution to prevent uncontrolled flow.

The main causes of wasteful production in oilfields are:-

(a) the incursion of water, and

(b) the failure to prevent too rapid a production of the gas contained in the producing sands.

In the development in Assam very careful measures have been taken to prevent waste of oil from these causes.

The successful exclusion of water from producing wells depends primarily on an accurate detailed knowledge of the correlation of the strata, and this has been achieved by prolonged and careful study of the logs of the wells which have been drilled. In the course of this study new methods have continually been applied, some of these were developed in Assam and others have been adopted from other oil producing countries. Of particular interest in this connection is an electrical method for distinguishing different kinds of strata in a well; this was first developed in France and soon after was adopted as an experimental measure in Assam; it has now become a standard operation in every well and has been in use for a number of years.

The entry of water into the well during drilling is prevented by the use of special drilling fluids which are made up from carefully selected clays and are given suitable chemical treatment. The development of the best 'mud fluid' for this purpose has been the subject of much detailed and expensive research by a staff of British and Indian chemists and it is of interest that the Calcutta University has collaborated in this matter with the Assam Oil Company and that the Punjab University has similarly collaborated with the Attock Oil Company.

For the permanent exclusion of water reliance is placed on the cementing of steel casing in an

Fig. 4.
The 'Mud Plant,' where the mud used for rotary drilling is prepared, chemically treated and reconditioned.

impervious layer immediately above the oilsand to be developed.

Water sometimes occurs in close proximity to the oil-bearing bands and this is rather more difficult to deal with; fortunately however it has, as a rule, a smaller adverse influence on the production of the oil, and it is now possible by measures which have been developed as experience accumulated, to locate this water and to deal with it at its source.

In water problems, as in many other aspects, one oilfield differs from another; and although experience in American oilfields has been utilized throughout the world, operators in other countries usually find it necessary to modify American methods to render them suitable for application to local conditions.

The conservation of gas is a matter which has received very close attention in the Assam field. Conservation has been accomplished in various ways: in some wells production is controlled by applying a back pressure at the well-head, for it has been proved in many fields that in this way the loss of gas can be retarded and the life of the well extended. In other wells the amount of gas produced is controlled by varying methods of production (*e.g.* by applying gas-lift or pumping, or by altering the size and depth of the pipe through which the well produces) until it is found experimentally that the optimum conditions of production have been

attained. Sometimes, despite variations in producing methods, it is found that a well persistently yields too much gas in relation to its yield of oil; such a well is closed in, either permanently, or until it is found by trial that underground conditions have so readjusted themselves that less gas is produced per unit volume of oil. It will be observed that this is an expensive business involving the earlier drilling of more wells so as to be able to rest a proportion of them when necessary.

Fig. 5.

A well producing under 'Gas Lift,' showing well-head connections, gas separators and collecting tanks.

system to the refinery and the gas to a special collecting system. From this system some of the gas is delivered to compressor stations situated at different points in the oilfield and compressed to a pressure which enables it to be reinjected into the oilsands. In this way gas which has already pushed forward its quota of oil is forced back into the sands where it assists to maintain the reservoir pressure and so enables a further quantity of oil to be pushed into the producing wells.

There is however a limit to the amount of gas which can usefully be reinjected in this manner; for if it is reintroduced in too great quantity, it is apt to establish channels and so to 'by-pass' the oil, the gas merely reappearing in other wells without doing any useful work. In order to force the gas back into the sands at a reasonable rate it has to be compressed to pressures as high as 900 lbs. per square inch, about ten times the pressure developed in an ordinary locomotive boiler. The gas which is not returned in this way to the sands is used for the prime movers necessary for the drilling and producing operations.

The successful development of the Assam field, as of other fields, has been rendered possible only by close co-operation between individual members of a large and highly qualified scientific and technical staff, recruited from the universities and colleges of Great Britain and India. This staff keeps in touch with the most recent developments in technique in the big oil producing countries of the world, and its members frequently visit America and Iran to study the latest innovations in oilfield practice.

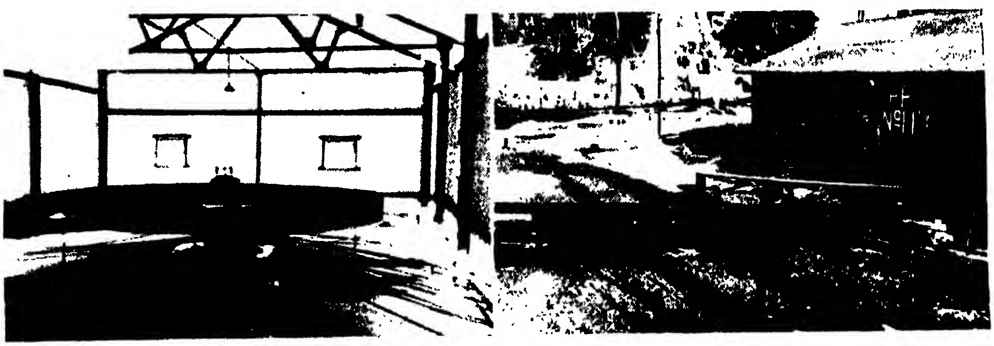

Fig. 6.

(a) Eccentric-Band Wheel providing the pumping motion.

(b) Distribution of 'Jerker Lines' from 'Central Pumping Power.'

By these methods, the gas in the oilsand is made to do its full quota of work in pushing oil into the well. This however is by no means the end of the usefulness of the gas, for having brought oil into the well the gas accompanies it to the surface where it is carefully separated, the oil going in an enclosed

Basic Factors of Personality

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SCIENTIFIC interest in the problem of the human personality may be said to have begun about half a century ago with the clinical psychiatrists' study of a few cases of divided personality in France and America. It has received a great impetus recently from the psychotechnicians' attempt to evolve suitable tests by which moral and social traits of persons may be determined. Though much work of importance and interest has already been done, the tests seem to be handicapped by a mechanical conception of the human personality underlying them.

The human personality is essentially dynamic and psychology has yet to supply a dynamic concept of personality. The Gestalt psychologists headed by Köhler and Koffka rightly point out that man's character is not an algebraical sum of separate traits but is a functional whole with mutually interacting parts. For definite light on the dynamic concept of personality, however, we shall have to go to the Freudian psychoanalysts and to a group of child psychologists who have made a special study of the development and functioning of the total personality in different concrete situations of life.

Recent revision of Freud's theory of neuroses supplies us with a basis for the dynamic concept we require. The old view explains neuroses as due to conflict between repressed sexual tendencies and the conscious mind or Ego. The new one goes into a deeper analysis of the latter factor and discovers a specially differentiated part within it, which, though very actively concerned in the conflict, is itself largely unconscious like the repressed sexual tendencies themselves. We have three conflicting factors now instead of the original two, and Freud names them as Id, Ego and Super-ego. These three in their dynamic interaction may be said to constitute the fundamental scheme of a man's personality. We should gather all important biological and other psychological information about a man and know, for example, about his heredity, favourable and unfavourable environmental conditions of his life, his health and his difficulties, his intellgence and his tastes, but, for a full and real understanding of his personality, we should know how these biological and other psychological factors affect the interaction of the three fundamental forces of Id, Ego and Super-ego in his nature.

Freud's theory rises out of a clinical background, but it is applicable to normal as also to abnormal persons. No attempt has yet been made, however, to give it a wider biological basis. Can we view the intricate problem of human personality in a broad perspective of animal evolution?

In view of the fact that both animal and human behaviour develop by gradual modification of a few fundamental instincts, it is interesting to compare the general principles of animal intelligence with those by which human personality is moulded into its complex shape. We can mention three such broad principles of modification of animal instincts.

1. The most general principle of intelligence underlying all processes of learning is integration. When an instinct starts activity in the organism, a part of original reactions taking place in a particular order serves to satisfy the instinct. Learning consists in integration of these satisfying reactions. Integration has two phases: inhibition and facilitation. The former precedes and prepares the way for the latter. But if it exceeds a certain limit it has the opposite effect and hinders learning. 'Strong emotion during the learning process has such an inhibitory effect on integration.

2. Given certain reactions, integration welds them into unity. It is after all a mechanical principle and cannot explain original selection of reac-

tions, nor account for occasional variation of already learned reactions in the same external situation. As Kurt Lewin suggests, we shall have, therefore, to accept a second general principle in dynamic interrelation of an animal's instinct and his environment. This interrelation has to be supposed to be present from the very beginning of the learning process.

3. For explanation of modification of instincts along higher forms of animal behaviour, we shall have to suppose a third principle in addition to the two already mentioned. It may be described as the principle of sustained tension. It implies increasing capacity to hold under check the physical and psychical tension which excitation of an instinct must involve. There cannot be any doubt that if intelligence is to act as a really efficient principle of successful adaptation, it should gradually acquire this capacity. As one goes up the animal scale from grade to grade, one can see that the adaptive behaviour actually gets more and more complex and the capacity of internal control over motility correspondingly increases.

Coming next to the principles of the development of the human personality, it may be said that behaviour on the human level gets very much complicated on account of the social factor. We can mark out three broad stages of growth of the human personality. The first is characterized by inadequacy of organic intelligence and compensation for it by the social environment, the second by clash with the social environment, and the third by origin of the Super-ego.

At birth the intelligence of the human child is not sufficiently strong to help him in adapting himself without help to the new complex conditions of his life. Social environment secures this necessary adaptation through the loving care of the mother or the nurse. The latter soon becomes a centre of his instinctive and pleasure-giving activities and is thereby able to draw upon himself a considerable amount of his love impulses. An emotional rapport is soon established between the mother and the child and a considerable change in the original child nature takes place as the result of the process of primary identification. It is a method of direct influence of one mind upon another, and is a very important source of learning and of habit formation in the earliest stage. It is not confined to the child's relation with his mother, but later on extends also to his relation with other persons and even with inanimate objects. As he grows up he passes through a large number of separate identifications resulting finally in his character. Incompatible identifications give rise to contradictory beliefs and traits in life. These explain why brilliant votaries of science should be hugging sometimes deep-rooted superstition in the private chamber of their minds.

Aggression follows love very soon in the child's relation to the world. To any attempt to check him he naturally reacts by aggression and anger. A state of ambivalency follows and he gives out love and hate for the same person and object. But in course of time he realises the bad effects of his aggressive attacks on others, and as these mean the risk of withdrawal of love by the dear elders, he finally tries to keep the emotions of love and hate apart in their application to the world. He hates some persons and objects, while he reserves his love for others. He tries also to check aggression in his mind. Need for a more drastic method of dealing with aggression arises when the emotional tussle with the social environment becomes complicated in late infancy by the development of the Oedipus complex. The child's mind finds itself, then, in a very critical situation and after trying different methods of defending itself against its own dangerous impulses of sexual and aggressive type, it takes finally to repression. Vitally connected with this process is the question of the rise of the Super-ego.

The Super-ego is a permanent principle of control in the mind of the child that arises by gradual introjection or acceptance of the prohibitions, threats and moral advices of the parents. It substitutes the previous external direction of the parents by an internal self-directive ' voice '. The Super-ego has two parts: (*i*) Ego ideal, which is the conscious part, and which serves the mind by pointing to what is good and what is bad from the social side, and (*ii*) an unconscious part which is active in the act of repression. The unconscious Super-ego is actively vigilant. It detects the repressed impulse as it tries to come up and metes out a punishment if it is able to do so in the least. It

really embodies a considerable amount of the energy of the aggressive impulse originally directed to the external world and can be described as internalisation of aggression or recoil of aggression on the self. In psychoneurotics the severity of the self-punishing Super-ego is very great, in normal persons it is less and in psychotics an attempt is made to throw out the severe Super ego back into the external world. Anyhow, one may say that man, in his attempt to withdraw his *natural* aggression upon himself and to give pain to himself instead of to the world, has been acting in the true spirit of Jesus ever since the rise of civilization.

After reviewing the principles of intelligence as directing animal behaviour and those which direct the growth of the human personality, the question arises as to the place of intelligence in the general scheme of human personality. Though an adequate principle of adaptation in the animal world, intelligence seems at first to be relegated to a subordinate position in the human drama of life. It is usually described as a general quality of the mere intellectual functions of man. But we may take a broad view and say that it has merged itself into the activity of the Ego. The latter is invested at least with all the three fundamental properties that we have seen it to possess in the animal world. To integration corresponds conscious learning and reality adaptation which the Ego has to bring about; to dynamic interrelation between instinct and environment corresponds the Ego's power of reality discrimination; and for the third principle of sustained tension we have the difficult work of adjustment of the Id and the Super-ego which the Ego has to perform but which eludes its power so often in the cases of neuroses and perversions. Intelligence is confronted with a highly complex and difficult work. It has to evolve by trial and error new technique of adaptation, a technique that would meet not only needs of external environment but also those of man's own complex nature.

II

Anyhow, the three factors of Id, Ego and the Super-ego constitute in their interaction a definite pattern of personality for an individual. Once a particular pattern is set up in childhood, it usually continues to give a stamp to all future activities and experiences of the individual. Later changes in pattern may be due to marked environmental changes, or change in supply and disposition of instinctual energy, or may be brought about by special methods, such as, psychoanalysis. The normal mind retains relatively greater plasticity of development of the pattern as a whole. The functional relation between the reality and the internal structures of the personality which is to be found present in all cases except in some advanced types of psychoses takes place through two special mechanisms, *e.g.*, introjection and projection.

The patterns of the personality structure are different not only in normal, neurotic and psychotic persons, but also in different types of mental diseases and criminality.

In conversion hysteria pain represents the punishing motive of the Super-ego at the same point of somatic excitation as is used by the repressed sexual impulse for the purpose of the 'banned' gratification. In compulsion neuroses the opposed needs of punishment and repressed impulse are served by two separate processes, sometimes the former being carried out as a sort of advance bribe for the latter.

On the basis of analysis given here we may recognise three main types of criminal mind. The psychotic type is markedly anti-social because of a strong internal defiance against the Super ego and of the attempt to pursue it aggressively back into society from which it originated. The obsessive or neurotic type commits crime 'out of sense of guilt' and seems to be prompted by an unconscious need of punishment. The third type may go into crime on account of a poorly developed Super-ego or on account of intellectual deficiency which makes the development of a proper Super-ego difficult. The best way to deal with the first type of criminals is isolation, with the second type psychological treatment and what the third type really needs is reeducation.

There is no doubt that many normal persons are unnecessarily unhappy and inhibited on account of effects of strongly fixated Id impulse and unduly severe Super-ego. Many of our interests and aptitudes are dominated by these unconscious factors of our mind. In choosing a man for

vocation it is thus important to know his particular pattern of personality and specially to form an estimate of the amount and specific nature of the Id and Super-ego load on his Ego.

In the light of recent researches in personality development it would be unreasonable to lay too much emphasis on heredity and it is to be noted that the social factor largely responsible not only for bringing into being a healthy pattern of personality but also to maintain it along healthy lines ever afterwards. This it can not do, unless we revise our customary attitude to morality. The social attitude to morality supplies the unconscious basis to the individual's Super-ego which we have seen to play such a fundamental part in his personality drama. Like the morality of the neurotic, our traditional morality is fixated to a primitive form. As a static and rigid instituton of control, it knows only to prohibit, to warn and to punish. It is not surprising therefore that our erotic and social life cannot easily go out into fresh paths of adaptive achievements and we find in the world to-day a huge mass of human energy turned mad and destructive. A demon of aggression is stalking over the world and we have wars, death-dealing inventions of science, communal fights and many anti-social expressions of man's repressed instincts.

Modern psychology points a way out of the present tangle of man's love and aggressive impulses. It is *Sublimation.* Shall we be able to bind the blind and massive forces of our elemental hate and aggression by outwardly directed love?

Cinchona Plant

S. N. Bal

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CINCHONA trees producing the medicinal barks are natives of Tropical South America, where they are found in the deep forests of the mountainous regions of the western parts of that continent at a height of about 2,500 to 9,000 ft.

The febrifugal properties of the bark of the trees of certain species of cinchona were recognised by the Spanish Jesuits in Peru during the end of the sixteenth century and the bark was then known by the Peruvian name as "Quinaquina" meaning a bark possessing medicinal properties.

The tree, however, was not known to science till about 1739. By the middle of the 19th century living cinchona trees were first seen in Europe at the Botanic Gardens at Paris where these were grown from seeds collected by Dr Weddel during his first journey to Bolivia in 1846.

The Dutch in Java first started the cultivation of cinchona in 1854 with a number of species of cinchona and in 1858 seeds were first obtained from these plants with which they extended the plantations and after long and careful experiments they now cultivate only three following species which meet the requirements:

1. *Cinchona Ledgeriana*
2. *Cinchona officinalis*
3. *Cinchona succirubra.*

These and the hybrids between these are also the plants cultivated in India and on an average these species yield the following percentages of alkaloids:—

	Quinine.	Other Alkaloids.	Total Alkaloids.
C. Ledgeriana ..	5.49%	3.03%	8.52%
C. officinalis ..	2.93%	2.07%	5.00%
C. succirubra ..	1.40%	4.85%	6.25%

CINCHONA PLANT

In 1861 the first consignment of seeds and plants of cinchona reached Nilgiris from its native home in South America and in the same year a number of plants yielding the valuable alkaloid was brought from Java where a successful plantation has already been established and by the end of the year Bengal received a consignment of seeds as well as a number of plants from Java and subsequently a plantation in Sikkim Himalayas in the Darjeeling districts was started with only 289 plants of the several species. The plants were also tried to be grown in Assam, N. W. F. Province, Bombay and other places but for some reason or other these attempts ultimately met with partial success or failure. At the present time the plantations in the south (Nilgiris) and in Bengal (Darjeeling districts) are the only ones which have been successful in growing the species of cinchona yielding the valuable alkaloids.

Cinchona plants will not, as a rule, stand frost and they prefer a cool climate in which the contrast between summer and winter and between day and night temperatures is not very great. The method of propagation of the plants is by cuttings or from seeds. The former method is only resorted to when it is intended to keep some exceptionally good stock of species. Seeds generally germinate in from 2 to 6 weeks. The seedlings having 2 or 3 pairs of leaves are transplanted in another nursery and when they are about 4 inches high they are again transplanted for the second time to a similar nursery where they are allowed to grow to a height of 9 to 12 inches. They are then considered fit to be placed in permanent positions in the plantations. It is to be remembered that virgin ever-green forest is always chosen for the purpose and liberal manuring is required after the land has been prepared. When the trees are about 10 to 12 years old they are considered to be mature to yield the suitable bark to be handled with. The trees are generally completely uprooted and the bark is scraped off with blunt knives. *Coppicing* is also practised for collection of bark from some plantations where they are found profitable to do so.

As is well-known to detect adulteration of crude drugs pharmacognostical methods are to be resorted to. The microscopical examination of the bark of the true cinchona of commerce shows that the outer surface of thicker stems displays a characteristic brown, yellow or reddish colour as compared with a greyish or blackish colour of the bark of younger stems or branches. Though the colour of the bark varies according to the locality where the plant has been grown and also the manner in which the bark has been dried, but there is always a permanency of the fundamental colour on twigs, the stem or branches of the same species. In the fresh condition the colours are pale but upon drying they fully develop the particular tint and these remarkable change of colour is always a prominent characteristic of the true cinchonas.

Microscopical examination reveals the peculiar character of the nature and position of thin lignified bast fibres, while the barks of the allied genera of plants with which the true drug is sometimes adulterated show that the laticiferous ducts are much developed and sclerenchyma forms large and often vertically extended bundles and the bast fibres are not completely lignified and also the tissue of these barks assume a greater firmness and tenacity than that of cinchona bark.

The alkaloids of cinchona bark are located in the parenchyma and, not in the bast fibres which can easily be found out by warming a thin section of a bark with caustic alkali which liberates the alkaloids from that tissue.

For extraction of quinine and other alkaloids the bark, after collection from trees, 10 to 12 years old, is dried and ground. It is then mixed with slaked lime and water and left for about 2 days to allow the cells to disintegrate. This mass is treated with caustic soda and agitated to form a homogenous paste when a quantity of hot oil is run into the mixture, and this takes up all the alkaloids from the alkali. The oil is separated and treated with dilute sulphuric acid which in turn takes up the alkaloids from the oil. This acid is treated with caustic alkali till neutralised when the crude quinine sulphate crystllises out forming a greyish pulp. After being centrifuged these crystals form into a cake containing crude quinine sulphate with about 10% of other alkaloids and the liquor contains cinchonine, cinchonidine, quinidine and other amorphous alkaloids.

The crude quinine sulphate is then purified by crystallisation when we get pure quinine sulphate.

It is seen that crude and unpurified crystals of quinine sulphate are twice put through the centrifugal separators and two mother liquors are obtained from the centrifuges. The first liquor contains cinchonine, cinchonidine, quinidine, amorphous alkaloids and a certain amount of quinine sulphate while the second liquor also contains these with a fair amount of quinine sulphate. A quantity of the second liquor is added to the first to bring the quinine in the mixture up to about 8-9% of the total. This mixture is treated with caustic soda to bring the alkaloids down as precipitate and dried which contains all these alkaloids and is known as cinchona febrifuge.

It has been said that cinchona was introduced both in Java and in India between the years 1854 and 1864 but when comparing the world production of cinchona and its products it is seen that Java produces about 90 % of the world's supply while India gives only about 5% and a very small quantity of bark comes from the forests of South America—the native place of the plant.

The quantity produced in India goes to meet only about one-third of what is actually consumed in the country and she along with the rest of the world has to look to the Dutch plantations in Java for her supply of the valuable drug. Java has got about 40,000 acres of land under cinchona while India has got only about 5,000 acres bearing the same trees. She requires another 10,000 acres of suitable land for the cultivation of this valuable tree to meet her present needs but it is said that India consumes only ½ the quantity of what is actually required due to the high price and other reasons and in that case India will have to increase her production about 6 times the present output.

An inquiry has been started on the possibility of increase of areas under cinchona cultivation by the Imperial Council of Agricultural Research. Mr A. Wilson has been deputed for the purpose and he started the work in 1937 travelling widely in different parts of India with a view to examine likely areas all over India. His report is awaited with interest. Not only the solution of the problem of finding out new areas for cultivation of quinine yielding species of cinchona is necessary but investigations should be started to find out means to increase the productivity of the areas under cinchona cultivation so that the alkaloidal contents of the bark may be increased.*

* A lecture on this subject was delivered by the author at the Indian Museum.

The Sexual Impulse from the Psychoanalytic Standpoint

Lt-Col. Owen Berkely Hill, I. M. S. (Retd), Ranchi

In 1898 Freud made his third great discovery, namely, that our sexual life begins at birth and not, as had been hitherto supposed, at puberty. That the civilised world should have had to wait for Freud to teach grown-ups something that is obvious to all who have eyes to see, may be regarded as another proof of the psychological ' blind-spots ' which seems to affect the understanding of all parents when observing their children. Fortunately for the world Freud is a Jew, for had he been a Christian it is likely he might have refused to give up the belief that children are little angels and, as such, are devoid of a sexual impulse. The publication of Freud's *Drei Abhandhungen Zur Sexual Theorie*

THE SEXUAL IMPULSE FROM THE PSYCHOANALYTIC STANDPOINT

(Three Studies of the Theory of Sex) caused a prodiguous commotion. Charles Mercier, one of the most cultured of English alienists, was stung to write:

"The Freudian finds tongues (talking dirt) in trees, books (on beastliness) in the running brooks, sermons (on sexuality) in stones, and filth in everything".

Most, if not all, psychoanalysts would agree that the *Drei Abhandlungen* is Freud's best book, a book that will go down to posterity. The description of the sexuality of the child is the central feature of the book. Freud maintains that in early childhood the sexual organs have not yet come to play a predominant part. The child draws its enjoyments from all sources, from all fields of sensation. The lips are the first and most important instruments of pleasure. The next important source of pleasure is the exercise of the muscular apparatus. When the infant falls asleep after being suckled it is enjoying the ecstasy of a well filled stomach. Freud maintained that all infants masturbate for a time. Before the fourth year of life, most children resume masturbation to forget it once more. For the third time, children masturbate at puberty and the memory of this generally persists into adult life while all memory of previous masturbatory activity is lost in the phenomenon of 'infantile amnesia'. Infantile sexuality is, on the one hand, a self gratification that is independent of the outer world; and, on the other, the investment of the whole body,—skin, mucous membranes, muscles, intestines, sense organs with desire and gratification. These tendencies of the child are described by Freud as 'polymorphically perverse'. There are obvious objections to the term. "Pansexualism" is a better one. Now, according to psychoanalytical teaching, this "pansexualist" trend never quite disappears. Truly, in most adults sexual pleasure is mainly concentrated in the genital organs, but in quite a number of others the influence of infantile "pansexualism" retains so much of its original power that it inhibits the full expression of normal sexual desire. Hence comes to existence certain "perversions" of sexuality, *e.g.* sadism, fetichism, inspectionism, exhibitionism and so forth. In all of these the sexual impulse is subject to premature arrest at a point that was 'normal' in the child. We may now ask ourselves why perversions and neuroses represent an arrest at an infantile stage of development or a regression to an infantile stage. To answer this question Freud formulated his 'libido' theory and based it on the motif of the greatest drama of all time, *Oedipus Rex* of Sophocles. In this stupendous play, Oedipus, son of Laius, King of Thebes, unwittingly kills his father and likewise unwittingly marries his father's widow. Every son, so Freud teaches, is jealous of his father and loves his mother. The theory of the Oedipus complex has supplied the energy to drive Freud's triumphal car round the world. This doctrine of Freud evoked bursts of indignation the world over. The signs of the Oedipus complex are so plain that it is truly amazing that the world had to wait until 1900 to have it pointed out. Who does not know sons embroiled with their fathers and over-tender towards their mothers? Who has not seen a grown-up daughter who is proud of being taken for her father's wife? No doubt, actual incest, that is sexual intercourse between persons within the prohibited degrees, does take place from time to time. But psychical incest is universal. None of us, however, is aware of experiencing incestuous passion because it is repressed from consciousness after severe struggles. Years ago, I had a patient, a young Englishman, aged 18. He told me that he often dreamed he was in bed with his mother but would always awake "before anything happened". After learning this, it was not difficult to understand why one evening he had gone to the railway track and allowed a passing train to cut off one of his arms! This patient's behaviour demonstrating another discovery of Freud's, the castration-complex. Freud contends that the fear of castration during the phase of the Oedipus complex is one of the most frequent and one of the strongest motive forces of repression. In his *New Introductory Lectures*, he writes: "The analysis of cases in which, not, it is true, castration itself, but circumcision, has been performed on boys as a cure or as a punishment for masturbation (a thing which was by no means a rare occurrence in English and American Society) has provided us with conclusive proof that we are right". But in addition to the castration-complex of the male, Freud formulates a

castration-complex for the female also which, he maintains, is started by the sight of the genital organs of the other sex. She immediately notices the difference, and, it must be admitted, its significance. She feels herself at a great disadvantage and often declares that she would 'like to have something like that too'. Thus she falls a prey to *penis-envy* which leaves ineradicable traces on her development and character formation, and, even in the most favourable instances, is not overcome without a great expenditure of mental energy. In Freud's own words: "That the girl recognises the fact that she lacks a penis, does not mean that she accepts its absence lightly. On the contrary, she clings for a long time to the desire to get something like it, and believes in that possibility for an extraordinary number of years; and even at a time when her knowledge of reality has long since led her to abandon the fulfilment of this desire as being quite unattainable, analysis proves that it still persists in the unconscious, and retains a considerable charge of energy. The desire after all to obtain the penis for which she so much longs may even contribute to the motives that impel a grown-up woman to come to analysis; and what she reasonably expects to get from analysis, such as the capacity to pursue an intellectual career, can often be recognised as a sublimated modification of this repressed wish". The discovery of her "castration" is a turning point in the life of a girl. Three lines of development diverge from it; one leads to sexual inhibition or to neurosis, the second to a modification of character in the sense of a masculinity complex, and the third to normal femininity.

From the foregoing it should be evident to what extent the doctrines of Freud have provided to those who accept them, an entirely new outlook on human sexology. To what extent his outlook conforms to the canons of science, time alone can show. To what extent his assumptions derived from his own observations, may possibly in time reveal themselves as unacceptable to the criteria of scientific validity, the fact remains that Freud has presented to the world a concept of psychic dynamism in regard to mental processes whatsoever that no other psychologist has hitherto been able to formulate.

Agricultural Research in Great Britain

MANY of the readers of this journal must be aware of the P. E. P. (Political and Economic Planning) which is an independent "non-party group, consisting of more than a hundred working members who are by vocation industrialists, distributors, officers of central and local governments, scientists, doctors, university teachers and so forth, and who give part of their spare time to the use of their special training in fact-finding and in suggesting principles and possible advances over a wide range of social and economic activities. The group has issued well over a hundred broadsheets on a considerable variety of subjects and has also published full-scale reports on such wide range of subjects, as coal-mining, cotton, iron and steel industries, international trade, the press, the social services and retirement pensions."

The present report* has taken more than 10 years in preparation by the research group of P. E. P. which is engaged in a survey of the use of organised science in the United Kingdom at the present time. The subject matter of this report is of the greatest interest to the scientists, administrators and the

*REPORT ON AGRICULTURAL RESEARCH IN GREAT BRITAIN, *published by P. E. P. (Political and Economic Planning), 16, Queen Anne's Gate, London, S. W. 1., (November, 1938). Price 8s. 6d. nett.*

public of India. In this report the adequacy of the provision made for agricultural research in Great Britain and its administrative machinery have been examined. The provisions for disseminating the results of agricultural research have been set-forth and critically assayed and instances have been cited illustrating the topics handled in the report.

In Great Britain agricultural research is controlled by a complex group of central government organs, of which the Agricultural Research Council, which is supervised by a Committee of the Privy Council, is the chief advisory body, but it has also certain executive functions. The bulk of the actual research is carried out by specialised research institutes and the advisory work lies in 17 provincial centres. The final link with the farmer is provided by the county advisory services through the agricultural organiser in each county.

The A. R. C. co-ordinates the whole field of agricultural research in Great Britain. It has at present only one research station of its own in Berkshire, but employs a number of research officers at various institutes. " The actual research is, however, carried out at about 50 different institutions, some of them are primarily educational in purpose, while about 20 are research institutes proper. Research institutes are of three types: Government laboratories or research stations, institutes attached to universities or university colleges and independent institutes." The last includes Rothamsted, and the John Innes Experimental Station. The aim is to provide " at least one centre for basic research in each of the principal agricultural sciences, namely, agricultural economics, soil science, plant physiology, plant breeding, horticulture and fruit research, plant pathology, animal heredity and genetics, animal physiology and nutrition, animal diseases, dairy research, preservation and transport, agricultural engineering and agricultural meteorology."

The advisory centres are located either in an agricultural college or in a university department of agriculture. Their advice is at the disposal of farmers. The county advisory service consisting of the agricultural organisers of the county councils in England and Wales and of the 3 agricultural colleges in Scotland " covers the whole country and acts as a free scientific information bureau for farmers and market gardeners. Most counties run farm institutes which give technical education in agricultural subjects, and demonstration farms or plots and some have full-blown research stations." A lot of private " research is carried on without any State subsidy at universities and in agricultural colleges and farm institutes, and by private firms, societies and individuals. There are two Imperial Institutes and nine Imperial Bureaux under the control of the Executive Council of the Imperial Agricultural Bureaux. They "provide an information and an abstracting service in the basic agricultural sciences and each of the Bureau is located at a research institute in Great Britain whose director acts as director of the Bureau. The expenses of these institutes and bureaux are contributed by the several Governments of the British Empire." About 90% of the expenditure of the agricultural work including advisory work in State-aided institutions in Great Britain is defrayed from national funds. *The total State-aid towards agricultural research for the year 1938 was at least a crore of Rupees.*

The report critically considers the merits and demerits of the present system and compares it with the structure of agricultural research in Northern Ireland, United States of America and Denmark. It emphasises that " the education services are the most fundamental link between research and practice. Education is the key to the psychological problem that faces the popularisers of scientific knowledge about agriculture. The crux of the problem is less inculcation of new knowledge and more assimilation of scientific principles. The acceptance of this attitude has long been shown to be necessary to progress. The fundamental cause of the farmer's mental inadaptability is the inadequate general education he has received. Civilisation based on technical discoveries demands that all children in rural schools should be taught the elementary principles of science. It is becoming clear that a reorientation in the schools is needed to turn the small farmer and farm worker into alert artisans of the soil, fully aware of the possibilities of applying scientific methods to farming. The beginnings of this change are already to be seen in such developments as the school gardens policy of the Board of Education, and the ' village colleges ' of Cambridgeshire." How much more true and the

need for their transformation into practice are these considerations for India!

Eight different aspects of research and ancillary services are defined in the report, all of which have to be found a place in the research and education structure. They are:

"(*a*) *Research Activities.*

(*i*) Background Research is the pursuit of knowledge for its own sake, the investigation of the fundamental scientific laws that underlie all agricultural and industrial enterprise. This is the function of the universities.

(*ii*) Basic Research is the study of broad subjects with a pronounced practical bearing, such as, parasitology and animal genetics. This is the recognised sphere of the research institutes.

(*iii*) *Ad hoc* Research is the study of specific practical problems, such as the control of foot-and-mouth disease. This is also the function of the research institutes, though a considerable amount is done by the provincial advisory staffs and privately.

(*iv*) Pilot or Development Research bridges the gap between laboratory experiment and commercial practice, as in the growing of new strains of plants. It is done at some research institutes, as well as at agricultural colleges, farm institutes and private research stations.

(*b*) *Ancillary Services*

(*v*) Information Service: This is a specific service comprising a continuous provision for the pooling of data between research workers, and the dissemination of research results among agricultural advisers and instructors. It is provided on the one hand by the publications of the Imperial Institutes and Bureaux and various other technical journals, and on the other hand by the provincial advisory service.

(*vi*) Extension Work: This is another specific service, consisting in spreading scientific knowledge among farmers, and reporting the farmers' problems back to the scientist. This is the function of the county organisers.

(*vii*) Public Relations Work: This consists in organised research presenting its case to the public and farmers in general by means of films, broadcasting, and other methods of mass publicity. This service is virtually lacking in Great Britain at present.

(*viii*) Training: This involves finding and educating personnel both for future research work and for key posts in all branches of agriculture, and is the function of the agricultural colleges and farm schools and institutes."

The report emphasises the desirability of a simpler administrative machinery and of strengthening the functions of the A. R. C. by giving it more executive powers, so that it would not only plan and co-ordinate research and research policy, but act as a central clearing-house for all matters relating to agricultural research, and control the extension and public relations services and that machinery should be provided to ensure close liaison between the A. R. C. and the Departments of Agriculture in any major development of agricultural policy. In addition to the present frame work of research institutes mostly devoted to a particular science or group of sciences which are considered to be the most satisfactory feature of the British agricultural research set-up the report recommends the foundation of a parallel series of institutes on a husbandry and product basis. There are already a few institutions in Great Britain working on this basis. The report also recommends the appointment of a number of research directors to co-ordinate research in each science or branch of husbandry under the direction of the husbandry committee of the A. R. C. as also the appointment of a liaison officer for the principal branches of agricultural research and especially for each husbandry institute in relation to agricultural economics. The main consideration for the establishment of a husbandry institute is that their staff will be in the best position to render effective practical advice through the provincial advisory service. The individual scientific workers in the research institutes follow their particular lines of enquiry and it is undesirable to divert them for general advisory work. Further the institutes on a husbandry basis will be able to collect and supplement, the knowledge gathered in the research

institutes and give them a form most suitable for advisory work. The county advisory service, it is recommended, should be placed under the control of agricultural colleges at the provincial advisory centres together with the agricultural education services at present provided by the counties. Each province should be divided into suitable areas, each of which should have an area organiser controlled by a chief organiser at the provincial centre. The area organiser would be in charge of the area institute and demonstration farm and in order to keep him abreast of recent developments it is suggested that close co-ordination and interchange of staffs between the provincial centre and the area institute should be effected. A series of bureaux organised on a husbandry basis is also recommended. The total annual expenditure on agricultural research in Great Britain is reported to be still considerably less than 1% of the total output of the land. It is suggested that additional sources of revenue should be tapped and contributions sought from the bodies who benefit from the work and also appeals for donations and endowments should be made. All these contributions are to be made to a central agricultural research fund which will allocate grants out of the fund.

Regarding the personnel of agricultural research, it is considered that the principal defect consist in the low salary scale and in the extension services there is chronic understaffing. The present arrangements for the spreading of scientific knowledge in agriculture is considered to be inadequate and the group recommends the setting up of a new Central Extension Service under the control of the A. R. C. which would supervise all extension work including provision of an adequate reviewing service for county organisers. The group considers that all the principal results in research should be published in two series, one of scientists and the other for farmers.

We have reproduced here some of the interesting passages in the report and it is so finely written that it will amply repay its perusal. An agricultural country like India requires such a study of her own problems and some of the suggestions are applicable everywhere. All persons interested in the development of the agricultural resources of India should procure a copy of the report.

J. N. M.

Notes and News

200-inch Telescope

In a recent issue of *Nature* (No. 3617, Feb 25, 1939) Dr. Walter S. Adams, Director of the Mount Wilson Observatory, Pasadena, has given a review of progress on the 200-inch telescope to be shortly mounted at Mount Palomar. The advice and assistance of numerous engineers and men of science throughout the United States have been utilized to advantage on many occasions in connection with the problems of design and construction of the telescope. The various aspects of the project may be mainly divided into three parts: (*i*) optical figuring of the 200-inch mirror, (*ii*) design and construction of the mounting and driving and (*iii*) construction and erection on Palomar mountain. The figure of the 200-inch miror approximates that of a sphere with a radius of curvature of 111 feet and its centre had to be hollowed out to a depth of about 3¾ inches. The optical tests of the mirror have proved to be quite satisfactory. No change is seen in the figure when the mirror is tipped from horizontal to vertical position or when it is rotated. The surface has been found to be reasonably free from zones, but a slight astigmatism has been detected which is being corrected by a small amount of fine grinding. The parabolic curve of the surface of the mirror will be only .005 inch deeper than the spherical curve, and this change will be done through fine grinding leaving the final stages to the polishing tool. The scale of the optical work may be gauged from the following figures. Nearly five tons of glass have been removed in the process of shaping and figuring only. About 20 tons of carborundum have been used for grinding and rouge has been purchased in quantities hitherto quite unfamiliar to dealers. The telescope mounting was under construction at the Philadelphia plant of the Westinghouse Electric and Manufacturing Company. They have been completed and transported to Palomar mountain, where erection is already in progress. The total weight of the complete mounting will approximate 500 tons. The north and south bearing of the telescope are on oil-films maintained under high pressure, while the declination bearings are of the ball type. The driving control of the telescope will be electric and the instrument will be provided with computing devices for automatic settings in position. The dome to house the telescope is 137 ft. in diameter and weighs about 1,000 tons and is mounted on thirtytwo trucks with spring adjustments and forged steel wheels. The rails are welded to avoid joints and have been ground to a bevel so that the motion of the dome gives very little vibration. The building is of double construction throughout with an air space between the two walls and heavy insulation on the inner wall and it is expected that the daily temperature range within the dome will not exceed 3 degrees. In the case of the 200 inch telescope, the field of sharp definition at the centre of the photographic plate is limited and the value of observing time is extremely high. The observational programme must therefore be defined as accurately as possible through preliminary survey work and identification of objects with auxiliary instruments of wider angular field and greater light efficiency. Two Schmidt telescopes have been planned for this purpose and are already under construction one with an effective aperture of 18 inches and focal ratio 2.0, and the other with aperture 48 inches and focal ratio 2.5.

The telescope will be a monument to the vision of Dr George E. Hale and the generosity of the Rockefeller Foundation. A paper on 'The Possibilities of Large Telescopes' by Dr Hale in *Harper's Magazine* led Dr Rose, President of the General Education Board to a gift for the California Institute of Technology of the telescope and complete astrophysical laboratories,

shops and auxilliary equipments. Fuller details about this 200-inch telescope can be found in the *Scientific American,* May and November, 1936 and August, 1938.

Science at the Golden Gate International Exposition

Science Service, Washington, D.C., gives an account of the Golden Gate International Exposition, the World's Fair of the West, at San Francisco, opened on February 19, where the research worker's genius and accomplishments in the various fields of scientific activity have been amply demonstrated. In the 'Hall of Science' at the Exposition, one sees rats thriving on synthetic food, insect friends of man fighting insect foes, two liquids mixed together becoming artificial rubber, a machine talking words that never came out of a human throat. The most interesting exhibits presented, are the 'test tube plants' grown by methods of 'soilless farming.' A significant contribution of agricultural science to modern farming is the method of growing plants in water containing nourishing chemicals instead of in soils and spectators are shown here what tremendous yields have been made possible by this method. A set of dolls are displayed not as play things but demonstrating how mother and father pass on their characteristics *e.g.,* colour of the eyes, to their children. There is again a model of California's and the world's greatest cyclotron devised by Lawrence, which has done so much in unravelling the mysteries of the atom. Pan-American Airways is staging a great aviation show by demonstrating the operation of Clippers that fly over the Pacific to China and the Philippines.

Treasures recovered from the bowels of the earth and the miner's art are shown in an artificial mountain where every type of mining operation on different key ores of the rich mineral areas of the West is shown in working form. Primitive objects of great anthropological and archaeological interests, recovered from countries bordering the Pacific and dating back to very early times, have been assembled. There is an interesting Federal exhibit, costing one and a half million dollars which is purported to show what Uncle Sam does for the average man from birth to old age by providing for public health service grants, maternity welfare and other social services. Visitors also have the chance to watch an iron lung at work, about which much has been heard recently a d which has saved many lives.

International Scientific Radio Union

Under the auspices of the International Scientific Radio Union it has been proposed to collect data concerning the sudden fade-out of radio signals at different stations distributed over the whole surface of the earth. A more accurate comparison with solar conditions will then be possible and these investigations are sure to throw further light on the question of solar control of the upper atmosphere. A British national committee has been formed under the chairmanship of Prof. E. V. Appleton to collect data for radio fade-outs at different stations in the British Empire. The British National Committee have invited Indian investigators to co-operate with them in the collection of these data and have sent out a request to supply detailed information regarding the dates and times of the radio fade-outs observed by them.

A New "Living Fossil"

The issue of *Nature* for March 18, 1939, contains a brief account of the discovery of a 'Living Fish of Mesozoic Type' by Dr J. L. B. Smith, Rhodes University College, Grahamstown. The Crossopterygian fish for which he proposes the name *Latimeria chalumnae,* gen. *et* sp. nov., is of a type believed to have become extinct by the close of the Mesozoic period about 50,000,000 years ago. This fish, 1500 mm. in total length and 127 lb. in weight, was taken alive by trawl-net at a depth of about 40 fathoms some miles west of East London on December 22, 1938. It is indeed a tragedy that for lack of preserving equipment at the East London Museum, the soft parts and a considerable portion of the cartilaginous skeleton were thrown away, but very luckily its skin with the skull and the terminal caudal portion of the vertebral column was mounted by the local taxidermist.

In its general features *Latimeria* is considered to be closely related to the Mesozoic genus *Macropoma* Agassiz (Coelacanthidae: Actinistia), but differs from all the known Coelacanthid fishes in a number of well marked characters which may even necessitate the creation of a new family for its reception. A full account of the species and of its taxonomic relationships will be awaited with considerable interest, for this discovery has been rightly called "one of the most amazing events in the realm of natural history in the twentieth century."

The value of such living forms of great antiquity for the study of Organic Evolution is incalculable and in

this connection we invite the attention of our readers to the article on "Living Fossils" by Dr Sunderlal Hora published in our April issue.

Sir Bryce Burt

Sir Bryce Burt, the Agricultural Expert and Vice-Chairman of the Imperial Council of Agricultural Research is retiring after 32 years' service in India. Before joining his present appointment, Sir Bryce had already done valuable work in the provincial sphere. He was Deputy Director of Agriculture at Cawnpore for many years and in 1921 was appointed to the secretaryship of the Indian Central Cotton Committee. In 1928 he became the Director of Agriculture for Bihar and Orissa, but in the following year the Imperial Council of Agricultural Research was established and Sir Bryce was chosen as its first agricultural expert. He later became its Vice-Chairman in 1935. Many tributes have been paid to the work of Sir Bryce for the Imperial Council of Agricultural Research and he is recognised as one of those mainly responsible for its growth in importance and beneficient influence and its development as a great organising and co-ordinating agency for agricultural research throughout India. He possessed not merely the knowledge of the expert, but organising ability, leadership, enthusiasm and the courage to face the country's manifold agricultural problems. Many important schemes go to his credit *e.g.*, the plan of co operation between universities and the Imperial Council for various research purposes, the introduction of the agricultural marketing scheme in 1935, the anti locust organisation and the inauguration of the Central Jute Committee scheme in 1936. In fact he has been associated with all the prominent features of Governmental activities in connection with India's agricultural progress for the last quarter of a century and the services he rendered to the Imperial Council in its earlier years will be long remembered.

Fission of Heavy Nucleus

An account is given in this issue of SCIENCE AND CULTURE (vide Research Notes) of recent investigations of Prof. O. Hahn, Prof. L. Meitner, F. Strassman and others on the bombardment of uranium nucleus by neutrons. As a result of very careful work by Hahn and Strassman the conclusion has been made that isotopes of barium are produced as a result of bombardment of uranium with neutrons showing for the first time that a heavy nucleus may split into two halves of nearly equal mass, which after some sort of decay form stable light elements. The work of Hahn and Meitner have been immediately followed by others in Europe and America in practically every laboratory equipped for work on nuclear disintegration, and the above conclusions have been substantially confirmed. Such fission of a heavy neucleus has been explained by Bohr by comparing it to the behaviour of a liquid drop. In a liquid drop when energy is added it may be retained to certain extent. If the excitation is such that the surface is considerably deformed, the surface tension may no longer hold the drop together and it splits into two parts. In the nuclear case also for smaller excitation energies the fission probability is very small and it increases with excitation energy. When fission takes place the two parts will naturally repel each other and gain considerable kinetic energies and in the case of uranium the calculated energy of the barium nucleus is found to agree well with the measurements from the ionisation intensity.

Matter in Inter-Stellar Space

In his George Drawin lecture delivered before the Royal Astronomical Society and later published in their Monthly Notice (*Mon. Not. Roy. Astro. Soc. 98*, 9, Supp. No. Oct, 1938) Prof. Charles Fabry discussed the interesting problem of existence and nature of the matter in the space between stars and reviewed the different methods of investigation and interpretation placed upon observations already made. The displacements of special lines, known as Döppler effect, give a measure of the radial velocity of bodies which give rise to these lines and in the case of stellar spectra, for any particular star the displacements should be the same for all lines. If the displacement for a particular line gives a different value of radial velocity for the star from that calculated from displacement of the other lines, it would indicate that the origin of the former line is due to interstellar matter and not to the star itself. Hartman's observations on the spectrum of a star made long ago showed that the velocity of the star calculated from the displacement of the hydrogen lines were far greater than the velocity calculated from the shift of H, K-lines of calcium. This indicated the existence of a cloud of stationary calcium in the intervening space between the star and ourselves. Much later, the

existence of other interstellar lines, *e.g.*, lines of sodium, titanium, potassium, discovered by Miss Heger, have been established. Some of these lines, however, cannot be identified and Prof. Fabry suggests their origin to be due to microscopic crystals giving absorption bands at very low temperatures. Others however think that they are due to molecules. From the displacements of these interstellar lines it has been possible to calculate the mean radial velocity of interstellar matter and it seems probable that interstellar gas has the same mean rotation as the galaxy. In other words, interstellar matter takes part in the general rotation of the Milky Way. Some observers have recently detected the presence of sodium lines in the light of the night sky and these have been shown to be emitted by very high layers of the atmosphere. The lines are intensified at twilight when the upper atmosphere is illuminated by the sun. Is it possible for the earth to supply the sodium present in the upper atmosphere or is it interstellar sodium which the earth might have picked up in its journey through space? As for excitation of these sodium atoms probably solar radiation might be responsible. But these are questions which await further work.

Modern Trends in Air Transport

Prof. W. F. Durand, emeritus professor of mechanical engineering in Stanford University, discussed the modern trends in air transport, in an address delivered before the meeting of the American Association for the Advancement of Science at Richmond, Virginia. Increase of carrying capacity, speed, range, economy, comfort and safety are the main objectives in air transport and their attainment would require proper improvement in the lifting system or the wings of the body, in the propulsive system and the control system of the machines. The lift of a wing increases with area, square of the speed and angle of attack. Assuming wing structures carrying the same load per unit area, while the lift will increase as the square of the dimensions, the volume and weight of the wing will increase as cube of these. This square/cube law indicating that weight increases at a greater rate than lift may cause the carrying capacity of a wing system ultimately to reduce to zero. But now-a-days the functioning of this law is being defeated by designers by a more efficient distribution of materials in the structure, the use of stronger and at the same time lighter materials, and improved aerodynamic design allowing increased speed for the same power. Early post-War commercial planes weighed from 3 to 5,000 lbs., with a wing loading of 8 to 12 lbs. per square foot, and optimum size under square/cube law was nearly reached. A new Boeing flying boat now under construction will weigh 82,000 lbs. with a carrying capacity of 10,000 lbs. while some projected designs for trans-ocean services are of 200,000 lbs. total weight and expect to carry load of 25,000 lbs. with a wing loadings of 30-40 lbs. per square foot. Speeds also have risen from 50-80 miles per hour to 150-200 miles per hour as normal cruising speeds and the figures are much higher for top speeds. At present 300 miles per hour appears to be about the practicable limit for commercial air craft. Range of flight without alighting and refuelling depends upon a balance between load and fuel carried. The present record is about 7,000 miles, but economic considerations bring this figure down considerably in the case of commercial air transport. The range can be greatly increased by taking advantage of reduced resistance of air at higher altitude. More economical flights should be possible in the substratosphere altitudes 20,000 to 3,00,000 ft. and such experimental flights are already being arranged. Planes are being built for substratosphere flight with a range of 1,000 miles at 180 m.p.h. carrying a load of nearly 9,000 lbs.

Comfort for passengers is an economic question and is today being met in a spirit of competition. As for safety, structural breakages due to bad design are practically unknown today and failures of power plant are rapidly being reduced. Flying and navigational instruments have been devised for all needs, including blind flying and landing in fog. It is rather difficult to foresee the part to be played by airships, lighter-than-air crafts, in commercial air transport. The restricted supply of helium which appears to be the only practical inert gas that can be used to avoid fire danger, is likely to be a serious impediment in the development of air ships.

Bihar-Nepal Earthquake

Tremors that shook an area of 1,900,000 miles, killing over 10,000 people and destroying numberless houses within five minutes, are recalled by the recent publication of a memoir on the Bihar-Nepal Earth

quake of 1934, by the Geological Survey of India. The memoir has been written by Dr J. A. Dunn, Mr J. B. Auden, Mr A. M. N. Ghosh and Mr D. N. Wadia and incorporates the results of an enormous amount of evidence collected from all over the country.

This earthquake which ranks with the greatest earthquakes known in history commenced at 2-13 p.m. on January 13 and lasted for five minutes in the central tract. The area of greatest devastation was in North Bihar and Nepal, but damage of gradually diminishing intensity extended into adjacent provinces. Wthin three minutes Monghyr and Bhatgaon were in ruins, as also large parts of Motihari, Muzaffarpur, Darbhanga, Katmandu and Patna, whilst in Sitamarhi, Madhubani and Purnea houses tilted and sank into the ground. Across the Ganges damage in such towns as Patna, Barh and Jamalpur was severe. Serious damage took place so far afield as Darjeeling and other places in Bengal. Within the limits of the Indian Empire the shock was felt over a distance of about 1,000 miles from the central tract, as far as Peshawar in the north west, Fort Hertz in the east, Akyab in the south-east, Bezwada and Ongole in the south and Bombay in the south-west. The shock was recorded in most of the seismological stations of the world. In India the shock was so strong that none of the seismographs in Calcutta, Agra or Dehra Dun was able to make a complete record of the earth-waves. The death roll of 10,650 was rather low, because the shock was felt in the afternoon when most people were awake. Had the disaster taken place at night, as was the case in the Quetta earthquake, the death roll would have amounted to hundreds of thousands in this densely populated tracts.

The phenomena associated with the earthquake were mainly ground movements, landslides in the Himalayas, collapse of buildings, damage to railways, the formation of great fissures in the ground, and the emission of sand and water from fissures and from innumerable fountains which suddenly appeared over the face of the country. Although recorded in other earthquakes, this emission of sand and water was a remarkable feature. In a zone of country called the slump belt, which extends from west of Motihari to as far east as Purnea, a distance of 190 miles, structures collapsed by slumping bodily into the ground. The earthquake was caused by a movement along a fracture zone in the earth's crust below the alluvium between Motihari and Purnea and possibily continuing to Dhubri in Assam. This movement began near Madhubani and extended rapidly west north-west, the maximum movement being in the neighbourhood of lattitude 26°21′ N and longitude 86°12′ E. There is evidence of a constant movement of the Himalayas throughout tertiary times, down to the present day, a movement directed laterally towards the Peninsula and giving rise to great horizontal thrust planes. On the Peninsula, in Chota Nagpur, there has been a succession of upward movements during tertiary times, giving rise to general tilting towards the north. The evidence suggests that in the Gangetic plains between there has been constant subsidence. It is believed that all these movements are related. In the downward folded zone of the Gangetic plains, between the two uplifted regions of the Himalayas and the Peninsula, a state of strain or potential fracture is presumed to exist.

The memoir concludes that from a scientific and engineering viewpoint the whole of Northern India within 200 miles of the foothills of the Himalayas must be regarded as a region particularly susceptible to severe earthquakes. To reduce mortality and damage in future earthquakes in these regions some form of building code is felt to be necessary. As a matter of fact such a code has been drawn up and enforced in Quetta with excellent results.

The most urgent necessity is, however, the creation of a small Government department to undertake research on earthquakes. This work would require more than occasional attention of the Meteorological or the Geological Survey and could be more thoroughly and authoritatively done by wholetime specialists in co-operation with the meteorological and geological survey departments and the universities. As a preliminary measure a number of seismographs to record the earthquakes is needed at specially selected stations throughout Northern India. The other lines of investigation requiring immediate attention are (*i*) the prediction of future earthquakes as to time and place and (*ii*) the means of minimising their effects. In this connection, the readers will find it interesting to read the editorial on the Great Quetta Earthquake in SCIENCE AND CULTURE *1*, 63, 1935.

Prof. J. C. Ghosh

The Council of the Indian Institute of Science, Bangalore, has recommended the appointment of Prof.

NOTES AND NEWS

J. C. Ghosh as Director of the Institute. Prof. Ghosh has been the Head of the department of chemistry at Dacca University since 1921, before which he was a lecturer in the post-graduate department of the Calcutta University. While in Calcutta, his investigation on the abnormality of strong electrolytes attracted attention from scientists throughout the world. The results of his work enhanced our knowledge of the nature of strong electrolytes and have been of great assistance in the subsequent development of the subject by Debye and others. During the last eighteen years he has built up an active school of chemical research who have made important contributions, covering different branches of pure and applied chemistry and of biochemistry. The main lines of work of this school relate to photo-chemistry, kinetics of reactions, photosynthesis and technical gaseous reactions. He has also been responsible for the development of agricultural studies in the Dacca University in addition to the inauguration and expansion of the chemistry department of the University. The department now provides facilities in education and research in pure and applied chemistry, biochemistry and soil science.

Though a 'pure' chemist Prof. Ghosh's activities are by no means confined within the four walls of his laboratory. He took part in the foundation of the Indian Chemical Society in 1924 and was its president. He presided over the deliberations of the last Indian Science Congress held at Lahore in January 1939. He is a member of the All India Congress Planning Committe set up by the Indian National Congress and also of the Industrial Survey Committee recently appointed by the Government of Bengal. He has been for a number of years a member of the Advisory Board of the Imperial Council of Agricultural Research and of the Governing Body of the Indian Research Fund Association.

We feel confident that Prof. Ghosh with his wide experience of administration and research and his knowledge of scientific and industrial research in this country, will be able to properly utilise the great resources of the Indian Institute of Science for the fulfilment of the aims of its founder, the late Mr Jamsetji Nusserwanjee Tata.

Bengal Industries Museum

The opening of the Bengal Industrial Museum last month under the auspices of the Industries Department of the Government, marks an important stage in their attempt towards the economic development of the Province. Bengal is probably the first of all the provinces in India to give a concrete shape to a government industrial museum. The Museum is housed in a spacious building and the exibits gathered represent the industrial products of the whole of the province and have been scientifically arranged and classified, and located in appropriate sections of the building. There is a very large number of exhibitors and exibits total several thousands. An excellent model of a modern pottery factory complete in all its departments is shown. Cottage-industry textiles occupy a good space with a varied display of the different types of products. Even the dead and dying industries have received attention with a view to resuscitation if possible.

The spirit of the Museum is typically represented in what is called a "Ticket" which reads: "Education. information, service, inspiration, progress, economy and the people." The tickets also enjoins everybody to develop the "Museum Habit."

Announcements

Dr A. M. Heron, lately Director of the Geological Survey of India proceeded last month on leave preparatory to retirement and Dr Cyril S. Fox has assumed charge in his place.

The following is an official list of the Presidents who will preside over the meetings of the different Sections at Madras, (January,1940) during the Twenty-seventh Session of the Indian Science Congress.

President Elect

Prof. B. Sahni, M.A., Sc.D., D.Sc., F.N.I., F.R.S., Professor of Botany, University of Lucknow.

Sectional Presidents

1. Mathematics — Prof. A. C. Banerji, I.E.S. M.A. (Cantab), M.Sc. (Cal.), F.R.A.S. (Lond.), F.N.I., Professor and Head of the Department of Mathematics Allahabad University.

2. PHYSICS .. Prof. K. S. KRISHNAN, D.Sc., F.N.I., Mahendralal Sircar Professor of Physics, Indian Association for the Cultivation of Science, Calcutta.

3. CHEMISTRY .. Dr S. KRISHNA, Ph.D., D.Sc. (Lond.), F.I.C., F.N.I., Forest Biochemist, Forest Research Institute and College, Dehra Dun, U. P.

4. GEOLOGY .. Prof. L. RAMA RAO, M.A., F.G.S., Professor of Geology, Central College, Bangalore.

5. GEOGRAPHY AND GEODESY. Dr SHIBAPRASAD CHATTERJEE, M.Sc., T.D.(Lond.), Ph.D. (Lond.), Docteur de l' Universitè (Paris), F.G.S., Lecturer-in-Charge of Geography, Teachers' Training Department, Calcutta University.

6. BOTANY .. Prof. Y. BHARADWAJA, M.Sc. (Punj.), Ph.D. (Lond.), F.L.S. (Lond.), F.N.I. (India), Head of the Department of Botany, Benares Hindu University.

7. ZOOLOGY .. Prof. B. K. DAS, D.Sc. (Lond.), Professor of Zoology, Osmania University College, Hyderabad (Deccan).

8. ENTOMOLOGY .. Dr. H. S. PRUTHI, M.Sc. (Punj.), Ph.D. (Cantab.), F.N.I., Imperial Entomologist, Imperial Agricultural Research Institute, New Delhi.

9. ANTHROPOLOGY Rao Bahadur K. N. DIKSHIT, M.A., F.R.A.S.B., Director General of Archaeology in India, New Delhi.

10. MEDICAL AND VETERINARY RESEARCH. Dr. J. R. HADDOW, B.Sc., M.R.C.V.S., D.V.S.M., Veterinary Research Officer-in-Charge of Serology, Imperial Veterinary Research Institute, Muktesar Kumaon, U. P.

11. AGRICULTURE .. Prof. JAI CHAND LUTHRA, B.Sc. (Hons.), M.Sc., D.I.C. (Lond.), I.A.S., Professor of Botany and Head of the Botanical Section (Physiological and Plant Pathological Research), Punjab Agricultural College, Lyallpur.

12. PHYSIOLOGY .. Dr. W. R. AYKROYD, Director, Nutrition Research, Indian Research Fund Association, Conoor, S. I.

13. PSYCHOLOGY .. Dr. D. D. SHENDARKAR, B.A., B.T., T.D., Ph.D., (Lond.), Lecturer, Osmania Training College, Hyderabad, Deccan.

Prof. S. K. Mitra, M.B.E., D.Sc., F.N.I., has been appointed General Secretary of the Indian Science Congress Association vice Prof. J. N. Mukherji, D.Sc., F.C.S., F.R.A.S.B., F.N.I., who resigned from the office and has been appointed the Treasurer of the Association, both for the period ending on the 31st January, 1940.

Sir Abdul Kadir, formerly a judge of the High Court of Lahore, has been appointed a member of the International Committee on Intellectual Co-operation of the League of Nations. Sir Abdul is a specialist in questions of Islamic art and philosophy in India.

The Faraday medal of the Institution of Electrical Engineers given for "notable scientific or industrial achievement in electrical engineering" has been awarded to Dr. W. D. Coolidge, Director of the Research Laboratories of the General Electric Co., Schenectady. In the Coolidge X ray tube devised by him, the X-ray worker for the first time, was able to control separately the voltage and current applied to his tube and also the steadiness of running and constancy of output were greater than hitherto obtained with any other earlier type of tube.

SCIENCE IN INDUSTRY

Gas Grid

In line with the generation of electricity near the supplies of raw materials or sources of water supply and distributing the power over a wide area through grid system, coal gases are now being supplied from central sources. In Germany the Ruhr scheme has a total length of 580 miles and serves points over 400 miles distant. In order to supply metallurgical coke the coke ovens release large volumes of gases which are generally used for firing the ovens and in the iron and steel plants for heating furnaces and for steam raising. For iron and steel industry the blast furnace gas and producer gas may replace the wilful use of coke oven gas when cheaper gas can save the purpose. This coke oven gas may be used in other industries, town supply and domestic purpose. Both gases have practically the same heat producing value. The production of gas in retort plants for town supply and domestic uses has some inherent inefficiency in the method. From the coke ovens, besides the gas and the high grade coke, ammonium sulphate, napthalene, and benzol, which may be utilised for production of motor spirit are obtained which will enable the cost of manufacture to spread more evenly over the different products. A hint at an attempt at conservation of national coal resources may be found at the announcement of the first gas grid system in England to operate in the West Yorkshire district. For the coke oven plants, this public supply of the gas will bring some extra revenue after paying for the substitute gases to be used for the adjunct iron and steel industry.

Improved Radiometeorograph

The National Bureau of Standards (U. S. A.) has recently constructed an improved radiometeorograph, in which an electric motor weighing only 2 oz. drives an electric contactor to contact successively several measuring instruments. The motor takes so little current that it can run for several days from a single flashlight cell of the type used in 'pen' flashlights. Rotary contact arms are attached to the pressure, temperature, and humidity indicating instruments. The contact switches a small radio transmitter and the timing of the contact indicates the position of the measuring element. Very great accuracy is claimed in asmuch as the pressure measurement is reliable to 1 per cent, the temperature measuring to 1 per cent and the humidity to about 5 per cent. The equipment has proved entirely satisfactory for altitudes as high as 12 miles.

Photo-electric Cell in Steel Industry

Accurate temperature control is found to be necessary for producing steel of a particular grain size and tensile strength, specially in the case of steel produced by the open hearth process. This has lead the United States Steel Corporation's Research Department to utilize a photo-electric unit to control the temperature of the furance, which has affected saving as high as 50 per cent in the life of refractory brick lining. This unit views the top of the furnace—and not the molten mass—through windows in the sides. The supply of the fuel to the furnace is controlled by the photo tube, which in turn is actuated by the brightness of the roof of the furnace. This automatic temperature has not only resulted in improved quality of steel, but has also resulted in longer life in the refractory brick lining.

The unregulated furnace is usually closed for repairs after processing about 300 batches of steel, but when the automatic temperature control is used, 450 to 500 batches of steel have been produced before repairs were necessary. This has resulted in saving of thousands of dollars per furnace each year.

Detection of Toxic Gases in Industry

Sulphur dioxide may be encountered in possible dangerous concentrations at bone and glue works, cold storage and refrigeration plants, dye-making, dyeing and bleaching works, glass and pottery works, ore roasting (metallurgical works), petroleum refining works, rubber works, sulphuric acid works, and tanneries. It is also encountered in fumigation and disinfection. A concentration by volume of one part in 2,000 is dangerous for even short exposures and one part in 100,000 is the maximum concentration allowable for several hours' exposure. The standard method developed for the detection of this gas depends on drawing a sample of the atmosphere by a hand pump through test paper treated with starch and potassium iodate to which potassium iodide has been added. The test-paper becomes stained a brownish colour and the concentration is determined by comparing the stains with a standard colour chart. Concentrations down to one part in 250,000 can be estimated by making not more than ten strokes with the hand-pumps.

Another gas, benzene vapour is produced during the manufacture of coal gas and the distillation of coal tar. It may be encountered in dangerous concentrations in many other industrial stations including aeroplane works, cellulose paint, lacquer and leather cloth works, dyestuffs and intermediate works, explosive works, fat and glue works, gas works and coke ovens, linoleum works, motor fuel blending works, paint and varnish works, pharmaceutical and perfumery works, rubber works, spray-painting works, and tar distilling works.

In high concentrations benzene acts as a narcotic (acute poisoning). In low concentrations over a prolonged period it affects the blood and the blood forming organs of the body (chronic poisoning). Individual susceptibility is well recognised, women and young persons being particularly liable to suffer from chronic poisoning. Analyses of air in factories where poisoning has occurred give values ranging from 1 in 200 to 1 in 500 parts of benzene.

The chemical test, which is capable of detecting concentrations down to 1 part in 10,000, involves the absorption of benzene vapour in concentrated sulphuric acid containing a trace of formaldehyde. An orange brown colour is produced, even traces of benzene being sufficient for this result. The test is carried out by drawing a sample of the atmosphere under test through a tube containing the reagent by means of a hand pump of definite capacity, and determining the number of strokes required to produce a certain standard depth of colour.

The situations in which nitrous fumes, another toxic gas, may be encountered in dangerous concentrations include ammonium nitrate works, celluloid works, dyestuffs works, explosives works, nitric acid works, nitro-cellulose paint, lacquer and leather cloth works, photographic film works, sulphuric acid works (chamber process). They are also encountered in electroplating, engraving, metal cleaning and photogravure processes, and are formed during oxy-acetylene welding, particularly when an oxy-acetylene flame plays on cold steel in a confined space. They have caused fatalities during the heat treatment of metals in molten nitrates.

Concentrations stronger than 1 in 10,000 are frequently fatal if breathed for more than a few minutes. It is therefore most important to note that a concentration which is dangerous to inhale for even a short time may be hardly noticeable, because no disagreeable symptoms may be produced. For this reason any atmosphere in which nitrous fumes are noticeable either by smell, irritation, or colour, should be regarded as dangerous. The chemical test is sufficiently sensitive to be readily capable of detecting a concentration of 1 part in 100,000. The standard method of test which has been developed depends on the Griess-Ilosvay reaction. It is carried out by drawing the atmosphere under test by means of a hand pump through a tube containing the reagent (a mixed solution of α-napthylamine and sulphanilic acid in acetic acid) until a rose-pink colour of standard depth is reached. From the number of strokes of the pump required to produce the standard colour, the concentration of nitrous fumes present can be obtained. The Department of Scientific and Industrial Research of Great Britain has released leaflets dealing with the detection of these poisonous gases produced in industrial process including charts and shade cards for comparison.

Indian Sugar Industry

With the grant of protection the Indian sugar industry had a sudden and rapid growth. As a result, the annual import of sugar has nearly stopped and on the other hand, the country is faced with the problem of over-production.

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In an article in the *Capital*, Dr Francis Maxwell, observes that the industry has not developed on progressive stages and there are various flaws and faults. In fact the existence of the industry depends upon Tariff Protection. Whereas the bulk of the world's cane sugar is produced within the tropical belt, in India 90% of the factories are situated in Upper India which lies outside the tropics. Hence the climatic conditions are unfavourable and India suffers a great handicap in respect to the quality of cane. Again, the bulk of the crop is grown by *ryots*, whose holdings consist only of a few acres of land, in most primitive lines. The average yield of cane in India is 300 to 400 maunds per acre while the average for Java last year was 1520 maunds. In the Punjab, U.P., and Bihar the canes are of stunted growth, of need-like appearance and of fibrous nature. The sucrose content of Indian cane is approximately 1.5 to 1 point lower and the purity of the juice is 6 to 5 points lower than the canes of other countries while the fibre content is about 2 to 3 points higher than elsewhere.

When the sugar boom came a good number of factories were purchased and started in India without sufficient technical knowledge and forethought regarding future expansions. Extensions made in later days have made such factories un-balanced and also uneconomical to work. Gradually, however, this defect has been rectified and today there are factories which have reached a good standard of efficiency. In the factories erected prior to the earthquake of 1935 installation of pumps were avoided and utmost use was made of gravitational flow in the consecutive stages of manufacture. This naturally resulted in tall buildings with a number of stories which had a severe test during the earthquake. It has now been realised that the "Ground Level" type of factories is best suited to Indian conditions and also gives ease of supervision and provides light and air to the workers.

The recovery of sugar from cane is on the average low in India (about 9%). This is due not only to the poor quality of the cane but also on the bad design and layout of the plant. The common practice of increasing the rate of crushing without any heed to the capacity of the mill results in low extraction. The average milling efficiency is 90 whereas the Java figure, compared to the same fibre basis is 93 to 94. There are also only few factories in India the figures for boiling house recovery of which can stand well in comparison with those in Java. In spite of cheap labour the cost of production is nearly twice that of Java (Rs. 6/- per maund excluding Excise Duty). This is because the proprietors ignore the fact that the efficient running of a factory "entails a competent staff in both the engineering and manufacturing departments and able engineers and chemists require remuneration commensurate with their merits and experience."

Natural Aluminium Silicate for Refractories

Kyanite, a natural silicate of alumina, is finding a steadily growing market for the preparation of refractories. It is not used in raw state but is first fired at 1450°C to 1500°C and then ground ready to be mixed with the bond. This preliminary firing completes a large volume change which would otherwise take place on burning and shatter the brick. The product of calcination is known in the trade as "Sillimanite" a misnomer which often leads to confusion. Sillimanite and andalusite are other two natural minerals of the same chemical composition as kyanite and which also undergo the same decomposition on heating. But kyanite gives a better product and is easily workable. "Sillimanite" is being used for electrical furnaces, enamelling and glass furnaces and for other high temperature kilns. Indian kyanite is the most popular at present, as is reported in *The Chemical Age*.

Artificial Mica

A new transparent inorganic film material under the trade name of "Alsifilm", has been developed from bentonite clay. The material is expected to serve as mica substitute among other uses. Bentonite suspensions passed through a super-centrifuge yield minute tough flakes which when compressed adhere to each other without the assistance of a binder. The strong films thus formed are resistant to water, acids, alkalies and oils, and have a high electrical resistance.

Heavy Chemicals Manufacture in India

Considerable interest is being shown by the Government of the State of Baroda in the new Chemical Company, which has been launched by Tata and Sons Ltd., for the purpose of erecting and developing works for the manufacture of heavy chemicals at Port Okha, Baroda. The Government has subscribed a

large portion of the Rs 5,00,00,000 capital of the new concern, and the Dewan of the State has been appointed one of the first directors. The Okha Salt Works which the new company proposes acquiring also owes the success of its development to the interest taken in it by the Government which has always been anxious to develop to the full the industrial resources of the State. The initial programme of the new company will be the development of such products as soda ash and caustic soda, but the further development will include all heavy chemicals and fertilisers, with the border line products between the heavy and the fine chemical industry. Following the Imperial Chemical Industries, Ltd., who have obtained the license and lease for operating mines in the Punjab with a view to producing soda ash and other allied heavy chemicals, this Indian enterprise is very welcome.

Commercial Possibilities of Bagasse Furnace Slag

In the Applied Chemistry Department, University College of Science, Calcutta, work is proceeding which shows that the slag formed in furnaces burning bagasse as fuel (as in sugar factories) can be well utilised in enamelling and in the manufacture of bottle glass. A sugar factory crushing 16,000 maunds of cane daily will, it is stated, yield approximately 13.5 mds. of this slag which has the following composition:—

SiO_2	73.4%
Al_2O_3	2.81%
Fe_2O_3	1.6%
CaO	2.5%
MgO	4.7%
K_2O, Na_2O	13.41%
MnO	0.15%
P_2O_5	1.32%

The presence of MnO, which imparts affinity between metal and substance in enamelling, in the slag which is already in a fritted condition makes it suitable as a ground coating material. With incorporation of fluxing agents such as red lead, calcined borax, and magnesia very satisfactory results were obtained on mild steel. The inherent opacity of the slag also suggested its use simultaneously in cover enamel but in this case to obtain perfect and homogeneous colour and composition the batch mixture needs fritting. In the laboratory blue, black and yellow products have been obtained.

The slag was also used as a raw material for the manufacture of bottle glass. In the manufacture of glass, the cost for the soda ash is the chief desideratum. Most of the alkali which is used in India is imported from abroad. In bottle glass manufacture the R_2O type base is admixed to the extent of 30%. The percentage of alkali already present in the slag is 13.4% and as such the alkali requirements can be cut down by about 50 per cent. Other advantages claimed are that (*i*) the main bulk of the batch mixture being in a fused condition the heat value for the formation of soda lime-silica is lower; (*ii*) the duration of founding of glass is short and it ensures low fuel consumption; (*iii*) the shrinkage factor is small compared to the ordinary batch mixture which means increased production; and (*iv*) the small percentage of manganese present materially helps the tone of the colour of the resulting glass in spite of excess of iron oxide. The following composition yielded a glass of good fluidity:—

Slag	Slaked lime	Soda Ash	Red lead	Temperature	Melted after	Cleared after
110	15	15	5	1130°C	2 Hours	2.5 Hrs.

It has been calculated that a factory situated near the sugar producing area can produce glass at the cost of Rs 1/4/- per maund if the slag, which has no value at present, is obtained at 0 0/6 pies per maund. Factories situated outside the sugar area will have to incur extra cost regarding transport of the slag. A paper describing the details has been published in the January issue of the *Indian Ceramics*.

Scientific and Industrial Research in Great Britain

The Annual Report of the Department of Scientific and Industrial Research of Great Britain, for last year,* which has just been issued, gives the reader an idea of the immense field covered by the activities of the Department and of the problems, the solution of which has been sought through the co-operation of science and industry.

Food Storage and Transport

The report calls special attention to the results achieved under the Department's Food Investigation Board in the last few years. In this period the problem of the preservation of fruit, has been solved by the development of a new method known as "gas-storage." In principle, the method depends on adjusting the ventilation of cooled stores so that their atmosphere contains just the right amount of carbon dioxide. "Ten years ago," the report states, "there were no gas stores. Today they provide three million feet of storage and this is only a beginning."

Up to 1933 Australia and New Zealand could only send frozen beef to the United Kingdom. As a result of the Department's works, chilled beef can now be preserved for sufficiently long periods in special chambers enriched with carbon dioxide gas. This discovery has been rapidly applied commercially and in 1937 Australia and New Zealand sent to United Kingdom some three-quarters of a million hundredweights of chilled beef carried in this way. Again, fish, as ordinarily handled and stowed in crushed ice, cannot be kept really fresh for more than ten to twelve days. Methods have been developed, by which fish can be stored for two years and would be in excellent condition at the end of that period.

Research Associations

The growth of the movement fostered by the Department to encourage the development of co-operative research associations in various industries, is strikingly illustrated by figures given in the report. These show that over a period of ten years the annual amount subscribed by industry for such co-operative research has more than doubled, having increased from just over £120,000 in 1929 to about £265,000 in 1937.

Over twenty research associations are now functioning with the assistance of grants from the Department. The two largest are the Cotton Research Association and the Electrical Research Association. The former has now an income of over £87,000 and the latter an income of over £85,000 a year.

During the year a new Research Association was formed. This is the British Coal Utilisation Research Association which has taken over the activities of the Research Department of the Combustion Appliance Makers' Association and is to develop research on the general problem of the utilisation of coal. As a result of the offers of grant assistance made by Department, the Association will have a minimum income of £18,000 a year with a prospect of an annual income of £30,000 if full advantage is taken of the offer made.

Rural Electrification

The Electrical Research Association has been devoting attention to problems arising in making electricity supply more readily available to farms and in its more efficient application to agriculture and horticulture. It is difficult to ensure that the electrical loads obtained are sufficient to justify the cost of giving the supply, and, bearing in mind that future connections will be mostly to isolated farms or small groups, this consideration has increasing weight. Two general lines are being considered; firstly, the possibility of reducing the cost of connecting up isolated consumers and, secondly, the problems involved in the application of electricity to various farming operations so as afford an economic gain to the farmer and a more appreciable return to the supply undertaking.

*Summary of the Annual Report of the Department of Scientific and Industrial Research for the year 1937/38. Published from H. M. Stationery Office, Price 3/- nett.

SCIENCE IN INDUSTRY

Textiles—Cotton and Wool

Cotton.—During the year, a new machine shop and a new laboratory building providing altogether 46,000 sq. feet of additional accommodation were completed at the Shirley Institute, the headquarters of the Cotton Research Association. The new machine shop is equipped to enable the Association to construct the first model of any new machine without the delay of going to outside machinery firms for experimental constructional work. The laboratory block is to be used for experimental work leading to the design of new machines and for studying the behaviour of cotton in them when completed. Work on the opening and cleaning of cotton is also being carried on in the new buildings. A range of finishing machinery has also recently been installed at the Shirley Institute, which is already in constant use testing out on the works scale results obtained from fundamental work in the laboratory.

A programme of large-scale work has been begun on the problems connected with 'finishing' and, 'crepeing'. The factors governing the production of the crepe are very imperfectly known and following upon a mathematical analysis of the problem, the production and processing of crepe fabrics under accurately-controlled conditions are now being investigated.

One section of the cotton industry is devoted to what is called "waste spinning." The starting product of this section is the waste material from other sections and consists of two types—"soft" and "hard" waste. The former comes from the various processes necessary before actual spinning takes place, and the latter is spun yarn which must, as it were, be "un-spun" and reduced to a non-thready nature before it can be again made use of. During the year machinery for dealing with both types of waste has been installed and attention is being directed to the solution of problems arising in the production of yarns from such materials. The comprehensive spinning equipment of the Association now allows for investigations of the processing of textile fibres from the very short (less than half an inch) to the very long (twelve inches).

The Liaison Department of the Institute provides the link between the scientific staff of the Institute and technical men in the trade, and becomes with time more and more firmly established. The Department consists of statistical and technical assistants whose main duty it is to visit mills and keep the scientific staff *au fait* with processing problems and difficulties which arise whilst explaining and interpreting the research results which have been communicated to members. Nearly 3,000 such visits were made last year. Another duty is to co-operate with practical men in specific mills in the investigation of special problems which have been put up to the Institute.

Wool.—Commercial working has begun on the Wool Industries Research Association's chlorination process for the production of wool resistant to shrinkage, and the trade mark "Woolindras" has been registered to preserve the new standard of unshrinkability attainable in woolen goods placed on the market.

An entirely new method of producing non-shrinkable wool is under investigation. In this process the use is made of certain "enzymes" which act on protein. These are completed substances present in living cells. One type suitable for the process is papain, a substance present in the milky juice of the tropical fruit called papaya. The activity of the substances can be controlled chemically and they appear to have a specific action on certain regions of the wool fibre.

The development of the process for the rubberization of wool has been continued and quantities of various types of wool yarn have been treated in order to test the properties of fabrics made from wool. The treatment, has proved advantageous for various types of woven and knitted fabrics in which resistance to wear or avoidance of the objectionable "balling-up" which may result on wearing surface of garments made from loosely-twisted yarns are matters of importance. The resistance to wear of carpets also appears to be greatly improved.

Iron and Steel

In the iron and steel industry the Industrial Research Council of the British Iron and Steel Federation is approved by the Department for grant under the research association scheme. Through the medium of the numerous research committees of the Council, the services of the scientific and technical personnel of the industry are extensively used to effect a comprehensive co-ordination of all research activities, not only in the iron and steel industries themselves but also in the steel-using industries with which there is collaboration. An extensive scheme of research has been developed

which has involved an increase in the annual expenditure from £11,124 in 1929 to £39,554 last year and for the current year an estimated figure of £50,000. Research into rolling mill design and operation has been begun. The work involves two aspects, namely, the engineering, concerned with the rolling mill as a machine, and the metallurgical, concerned with the plastic deformation of metals and its effect on rolling mill operation. Work on the production of materials for light-weight concrete produced by "foaming" blast furnace slag, previously unsaleable has been completed. The production of materials for heavier concrete from air-cooled slag is now being investigated.

The National Physical Laboratory is co-operating with the Research Council and the Iron and Steel Institute in investigating methods for measuring the temperature of liquid steel in open hearth furnaces. The aim is to attempt to adapt the platinum thermocouple and the optical pyrometer to the conditions of the open hearth furnaces.

Refractory materials have been found which will afford adequate protection to the measuring instruments when immersed for short periods in molten steel without slag and in the next stage of the investigation an attempt is being made to obtain such slag-free conditions in an actual furnace as will enable the "quick-immersion" method to be brought into use.

Under the Refractories Research Association, investigations have been made on bricks taken from the linings of blast furnaces. The deterioration occurring at different zones of a furnace due to the action of carbon monoxide, alkali salts, zinc and lead compounds, etc., has been examined. The results have indicated methods for producing fire bricks, which are resistant to the action of carbon monoxide. Suggestions have also been made regarding the composition of cements for joints between bricks in the various zones.

The Cast Iron Research Association has now produced cast iron having a tensile strength of 60 tons per sq. inch. A few years ago, a strength of not more than about 12 tons per square inch could be obtained. Tests have been carried out at the National Physical Laboratory on crank-shafts from materials supplied by the Research Association. Aluminium cast iron shows particular promise as a heat-resisting material.

Tests and Special Investigations

Besides carrying out its immense programme of general research, both the Department's own research organisations and the various co-operative research associations answer tens of thousands of enquiries from industry every year and carry out hundreds of special investigations to solve practical problems of industry. In twelve months, at the National Physical Laboratory 41,500 routine tests on instruments and materials were made. Over the same period upwards of 530,000 clinical thermometers and 20,000 taximeters for cabs were tested.

Points from the Report

The following are some further points from the report. New uses for rubber are likely to be found, as a result of the development of the Rubber Research Association of a simple process for preparing powdered rubber from plantation sheet or crepe.

Investigations carried out at the National Physical Laboratory into the design of herring drifters have shown that the forms of hull at present in use can be made to give a reduction of some 40 per cent. in power without loss of seaworthiness. The application of this work would mean the saving of hundreds of pounds a year in the fuel costs of any drifter built to the new design.

At the Fuel Research Station a process is being studied of producing motor spirit by heating the gases produced by passing steam over red-hot coal. In the course of this synthesis a wax is produced from which soap has been made. Water softening materials have also been prepared from coal and the possibilities of using fine coal dust instead of oil in Diesel engines is being investigated.

The gross expenditure of the Department last financial year was £872,127 and the receipts from industry and other sources were nearly £235,000.

World Industrial Trends—1938

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The political atmosphere prevailing in the world compels every country towards self-sufficiency or "autarkie". But nature has not been equally kind to all as regards supply of raw materials; so earnest and furious attempts are being made in every country to find substitutes either for the raw materials or for the products made out of them. Commodities of absolute necessity and of luxury, not always easily distinguishable from one another, must be manufactured from indigenous raw materials. This is to provide against possible isolation during war-time as well as to satisfy the vanity of being independent of other countries as demanded by patriotism. More immediate incentive in this direction is to build up a favourable trade-balance. Every industrially developed country is trying to increase export and decrease import. The paradox of this universal tendency should be apparent, but it is not. The last industrial depression creating misery in the midst of plenty should have led nations to a rational solution of this periodically occurring economic cataclysm. Even if these tendencies had not been present, the manufacture of "substitute" goods would have come, though with a less violent tempo, because the restless human mind is ever inquisitive and the creative genius in man is always urging forward. Feverish activities of various industrial organizations and government departments in different countries during the year 1938 will be briefly enumerated in this article to indicate the trend in this line.

Great Britain

Main activities of the country, because of the war-scare produced by the politicians, were devoted to the accumulation and continued ample supply of rare metals and other raw materials necessary for a long-term war. The principal effort of the Government had been to encourage those industries only which are directly engaged in the manufacture of armaments and their accessories. The industrial concerns having more foresight for the probable profits during the war-period are expanding their capacities. Sulphuric acid plants are increasing in number. Apart from Government contracts under the rearmament programme, agriculture still makes its claim. A large super-phosphate plant is under construction in East Anglia and the third vanadium catalyst plant is to be erected by F. W. Berk & Co., Ltd. This has a rated capacity of 24 tons per day of 100% sulphuric acid. Two-thirds of the total annual production of about one and half million tons of the acid (70%) was claimed by the Chamber-process.

A great deal of work was done in metallurgy. Magnesium which was used to be manufactured from carnallite is now to be made from English dolomite. Metallic lead and sulphur are to be produced simultaneously by the process of electrolysis of a solution of galena in a bath of fused lead chloride. Tarnishing of silver is prevented by applying an invisible coating of beryllium or aluminum oxide on the metal. Litheote, a non-vitreous baking enamel which can be applied quickly and easily to any metal, has been placed on the market by Newton Chambers & Co. Ltd. A new method has been invented for manufacturing red-lead by the vaprolite process which vaporizes the molten lead explosively and precipitates it in another chamber where it comes in contact with pure oxygen and is converted into red-lead of remarkable properties. Stannising is a new process for coating brass, copper etc., by suspending articles made from these metals for a few minutes in an atmosphere of hydrogen and stannous chloride vapour. The tin so reduced alloys with the metal, the thickness and composition of the alloy depending on the regulation of the temperature and time of exposure to the vapour.

Exploration for petroleum continued and oil was found at Dalkeith, Scotland. As in every other country so also in Great Britain considerable amount of research was devoted to the derivation of liquid fuels from coal. As an encouragement in this line of industry, a tax preperence of 8d. per gallon was introduced by the Govern-

ment to be in force for a period of twelve years. One hundred and twelve thousand tons of motor spirit are being manufactured annually by the Imperial Chemical Industries Ltd. by Bergius process. Manufacture of active carbon from coal was investigated further and a factory was erected in South Wales.

Researches at Teddington revealed base-and acid-exchange characteristics of certain types of complex formaldehyde condensation products of resinous nature. United Water Softeners Ltd. placed on the market a commercial water softener of this type. A novel method for moulding thermoplastics employs high-frequency alternating current to effect uniform heating, and it is rumoured that procedures have been devised for surface hardening of transparent resins, to render plastic lenses etc., less scratchable, and for making resins luminous. Distrene is a new transparent thermoplastic material developed by the Distillers Co., Ltd. It is said to have remarkable insulating properties and may be used either for injection or pressure moulding. Bakelite Ltd., has recently put on the market a new synthetic resin primer which deposits a coherent rapidly settling adhesive film upon timber. The British plastics industry represents an invested capital of over £5,000,000.

The manufacture of artificial fibres has been the most favoured of all industries the world over. In Great Britain, Courtaulds Ltd. besides being engaged in the production of casein wool produced a new kind of staple fibre claimed to absorb dyes better than others. A novelty which may become commercial was announced in London. It has to do with a process by which a film of gold less than 0.0001 inch thick can be applied. The fabric is dipped in an organic compound of gold, such as trialkylphospine aurous halide, which breaks up into its constituent parts when slightly heated. The thin film of gold is deposited on the fabric like a dye. It has been estimated that gold fabric by this process would cost about Rs 7/- per yard. Experimentally aluminium was woven into cloth.

Germany

Germany and Italy, the two totalitarian countries, have made immense progress in the manufacture of "substitutes" and "synthetics." Both are short of raw materials, and both are preparing for prolonged great wars. In both countries the technologists are finding out substitutes for natural resources by research. Gasoline from coal, rubber from lime and coal, sugar and alcohol from wood, textile from wood, nitrates from the air—all are becoming commercial products in Germany today. In the present Nazi system of government chemical industry has been given an unusual opportunity to develop new products and processes on a scale which would be impossible in a free economic system. Commercial production of synthetics, improved methods of conserving materials, of utilizing by-products and waste materials influenced the development of chemical industries in Germany during the past five years. The main articles of import into Germany were, and practically still are fats and oils, petroleum, rubber, textile fibres, and metals. Consequently gigantic efforts were made to produce articles from the adequately available indigenous raw materials *e.g.*, coal and lignite, potash and salt, wood and limestone.

The Kaiser-Wilhelm Institute fur Kôhlenforschung is studying hydrocarbon synthesis by the Fischer-Tropsch process, and a compact mass has been developed that is cheaper than the usual cobalt-thorium catalyst but still gives equal yields, and can be controlled to obtain a large part of the production as solid paraffin. About 60.000 metric tons of fatty acids are made from this paraffin annually. Tar fractions have been added to heavy oil from this process and the mixture has been successfully used as a Diesel fuel. Germany was able to supply more than half of its light motor fuel requirements from domestic sources in 1937, and is fast approaching self-sufficiency as new plants are being built to obtain motor fuels from lignite and hard coal, with sulphur and paraffin occurring as subsidiary products. Methanol and liquid gases, propane and butane are being used increasingly as domestic motor fuel. The change in the required admixture to gasoline of "Treibsprit" has caused considerable fluctation in alcohol output. Agricultural alcohol production, specially from potatoes, has been discouraged, while industrial production of alcohol from cellulose waste liquor, has increased the total production in 1937-38 to 1158 hectolitres. One half of this production is used in motor fuels. Alcohol obtained in wood-sugarization plants along with yeast and cattle fodder represents a new source of commercial alcohol.

The production of the synthetic rubber, "Buna", continues to rise as plant capacity increases, and at present covers about one-fourth of Germany's requirements of rubber. The production is subsidized by a

higher tariff on imported natural rubber, the proceeds of which are directly turned into new plants. This synthetic rubber is being tried even in the manufacture of automobile tyres. Of the projected 10,000 kilometres of new motor high ways about 2000 kilometres are already open to traffic and the number of automobiles on roads is one to every 45 persons of the population.

The prophecy that the future may be called the age of plastics will not be wide off the mark. These are replacing wood, metals, and alloys from many fields and are finding novel applications. Production of such plastics in Germany reached 45000 tons in 1937 and has increased since then; most of these belong to the phenol condensation groups. A plastic institute has been established at Frankfort on-Main and a school for plastics technicians at Halle. Research on plastics is vigorous, and standardization of synthetic resins is being attempted. Copolymers of styrene with acrylic esters, butadiene, cyclopentadilne, vinyl chloride, and vinyl acetate have been patented. Acid-and alkali resistant filter-cloth from polyvinyl ethers is being manufactured. Output of pyroxylin plastics has also been mounting steadily.

The world is at present politically dominated by the cold countries situated to the north of and around 40° northern latitude including the recent entrance of Italy in the arena, and all of them except Italy are already intensively industrialized. But Nature (in the animal and vegetable worlds) is not equally productive in these regions. Man has gone against Nature and curtailed fertility; textile-fibre producing plants like cotton, jute etc. and oil-seed plants do not grow in cold countries. And man, the rebellious child of Nature, is trying to remove these natural deficiencies and obstacles.

In Germany the cultivation of ramie and aromatic and medicinal plants has been receiving scientific aid. At Karlsruhe nicotine-rich tobacco plants containing 8 to 16 per cent of the alkaloid have been bred. A German research laboratory has succeeded in synthesizing a growth substance, "Belvitan", which influences, for example, the formation of roots on cuttings. Cellulose was prepared from brown coal waste. Cellulosic casing covered with copal is being used in manufacturing collapsible tubes. "Hofa" threads consisting of wood fibre stock and viscose are produced as a substitute for jute and hemp; "Vistra", resembling wool, and "Aceta" fibre with an air centre are other new textile materials, and another fibre consists of fish albumen on the outside of the filament around a cellulose centre. "Persistol" is a new textile waterproofing agent, similar to "Velan". By all these efforts, synthetic textile fibres have seen a phenomenal rise. The output of "cell wood" advanced from 19600 metric tons in 1935 to 46000 in 1936, to 1,00,000 in 1937 and to an estimated 1,50,000 in 1938. Germany leads the world in the production of staple fibre and occupies third place in rayon. New types of fibres are constantly being perfected, and the basic cellulose will soon be obtained entirely from domestic wood.

In the production of inorganic and metallurgical goods Germany still holds an enviable position in the world market. Sintered spinel, beryllia, alumina, magnesia, zirconia, and thoria were studied as special ceramic materials. Iron is being desulphurized by the use of soda ash. Local sources of alumina are under investigation, and an experimental plant at Lippe is using domestic clay. A process is said to enable the recovery of vanadium from the iron ores of southern Germany. The Nazi policy of "autarkie" (self sufficiency) has caused considerable replacement of certain metals by plastics, such as in spring house equipment, rolling mill bearings, seals, and printing types. Glass wool is being pushed for house insulation; hollow glass bricks are employed as heat insulation for constructional purposes.

The production of sulphuric acid from keiserite is under research; the output of pyrites has been increased; a number of coke plants are manufacturing sulphuric acid from hydrogen sulphide. It is asserted that Germany now supplies, largely through research results, about three fourths of her sulphur requirements.

Italy

Italy under Mussolini has developed rapidly both politically and industrially. Her chief achievements have been in electrometallurgy and metal products, synthetic fibres, liquid fuels, and to a certain extent in synthetic plastics. A synthetic cryolite plant was built, production of aluminium and magnesium was enlarged and a cadmium factory started operation. Italy has attained first place among European producers of rayon and short fibres, and in 50 factories together makes 16 , of the world's output. The daily produc

tion of casein following the installation of two new plants will be markedly enlarged, meaning a considerable increase in the output of "Lanital". Mixed with wool and rayon, "Lanital" yields a cloth of importance to Italy. "Cisalfa" and "Sinabeta" are made from mixtures of fibres produced from cellulose and animal protein. "Gelsofil", a new textile fibre derived from the bark of the mulberry tree, was developed. With all these achievements in synthetic fibres the country is well on its way to self sufficiency in this respect. In the liquid fuel line the commercial development of Sicilian asphaltic slate has been successful and it is expected that by refining Albanian crude oil and producing industrial alcohol Italy will meet her present annual demand of 2500000 tons of petroleum without any import.

Japan

Japan increased the productive capacity of most of her factories and established new ones. There is scarcely any industrial line which she has not tried and succeeded. Her novelties for the year have been the following: Formosan sugar cane has been increasingly used in the production of alcohol and paper; artificial bristles are being made by treating viscose threads with uric acid ("cellofil") and by filling a tubular viscose with a stiffening agent; Ryohei Inouye's process for preparing fibres from the proteins of soybean cake has been industrialized; Mutsumoto announced a new method for producing fatty acids from ash oil.

U.S.A.

The United States of America is placed in most favourable conditions: she is three times as big as India in area with about onethird the population of the latter. Placed between the latitudes 30° and 48°N her natural resources are immense, and, as it is, she enjoys self sufficiency in most of the important raw materials and finished goods. Manufacture is carried on very large scales and is controlled by huge concerns with almost unlimited financial facilities. Besides the various Government departments which carry on researches on the possibilities of raw materials, and private organizations like Mellon Institute, A.D., Little Laboratories etc., which take up industrial problems from private parties, every big manufacturing concern has its own research laboratories maintained by a part of the profit earned by the company. So new developments are more in evidence in this country than in others.

In the line of synthetic fibres the greatest novelty was in the manufacture and application of glass fibres. Many uses have been found for fibre glass and rubberized glass fabric, glass wicking, and glass wool for use as a garden mulch were announced. Electrical insulating tapes woven entirely from glass yarns were developed by Corning Glass Works. The uses of tempered glass "Herculite" were extended to doors and roofs, and glass-blocks for building construction were produced at Port Allegany. Specifications for such glass to be used for constructional purposes have been published by the Government. The cellulosic casing of sausages has gone down to one fourth of its price 12 years ago due to more extensive use and production, as also because of the reduction of cost of manufacture as a result of continued research. The annual production of rayon has reached 400,000,000 pounds in less than 30 years. Along with the growth of synthetic fibre industry, solvents of various chemical and physical natures are being manufactured mostly from waste products. Niacet Chemicals Corporation introduced two soluble aluminium acetates for the water-repellent treatment of textile fabrics. du Pont "Zelan" is another water repellent finish for cloth.

A prominent event of the year was the announcement by du Pont of a new type of resin called "Exton." It is being manufactured in the form of a plastic dough which is extended into filaments, used as a successor for pig bristles in tooth brushes. This type of resin will also soon make commercial entrance as artificial silk, called "Nylon". "Exton" belongs to the family of polyamides derived from polybasic acids and polyamines. Another American novelty in the field of synthetic fibres is "Vinyon", from polyvinyl resins; it has unique elasticity and fatigue resistance, is permanently water resistant and will not support combustion, is not affected by mineral acids and alkalies, and is not attacked by bacteria and fungi; "set" yarn is stable with respect to shrinkage and the knitting properties are exceptionally good.

Rubber and its substitutes are finding many new methods of treatment and applications. "Kaysam" process manufactures rubber goods direct from latex; moulded and cured latex foams came into use for cushions, pads, and mattresses. "Resistoflex PVA," a

form of polyvinyl alcohol, was introduced as a rubber substitute; huge storage tanks and reaction vessels are lined with rubber. Uses of large moulded and laminated plastic parts in automobile, aeroplane, and railroad coach construction have been partially successful. It is interesting to note here that in Germany a phenoplastic automobile body was produced and declared partly satisfactory. The importance of these experiments lies in the possibility of rapid production of machines in case of national emergency.

Lacquers seem to be influenced by the latest developments in the manufacture of synthetic resins. Compositions of new lacquers are based on cellulose polyesters such as acetobutyrate and on mixed cellulose ethers of the ethylbenzyl type. Continued expansion in the development of lacquers depending on urea formaldehyde resins combined with alkyds has been reflected in the manufacture of "Beckamines" and "Uformite" for use as lacquers and enamels.

In the liquid fuel line, where there are a number of research grants and process developments as evolved by different petroleum companies of U. S. A., a vast amount of work has been done to separate the individual constituents of oil fractions and to effect their subsequent transformations into other compounds into benzol and tuluol respectively, by high temperature and catalysis, which bring about first, dehydrogenation, and then cyclization. In a short space of 15 years petroleum technologists have made a 3-cent cut in the cost of manufacturing a gallon of gasoline from crude oil. Various solvents, special form of fertilizers, fungicides, insecticides, root-growing chemicals were put on the market. United States lacked oil seed-bearing plants except cotton. Now, after extensive and intensive trials extending over several years the success in 1938 resulted in the production of 400,000 lbs. of tung oil; soybean, an oil seed of many virtues, originally an inhabitant of China, is being cultivated successfully and every part of the seed is finding various applications. By a novel distillation process, a new line of products, "Neo-Fats," purified fatty acids from vegetable and fish oils being put on the market. The theoretically important laboratory method of molecular distillation, based on the difference in the mean free-paths of molecules, is being tried on fish liver and soybean oils. By the new method of afforestation of southern pines the country is expected to be self sufficient regarding wood-pulp for paper and cellulose.

In the metallurgical field, U. S. A. is the strongest as regards the production of iron, steel, aluminium, and to a certain extent copper. Nearly all the chromium, cobalt, nickel, tin, and manganese consumed in the country are imported. American blast furnaces are 60 per cent fewer in number than in 1889, but their continued capacity is 300 per cent higher, owing to scientific and engineering improvements. The U. S. A. Geological Survey reported the discovery of paying quantities of platinum bearing ores in southwestern Colorado, and beryl deposit was opened at Vista, California. The U.S.A. Bureau of Mines devised methods for the recovery of lithium from low grade ores and for the electrolytic production of highly pure manganese from ores. Metal alloy photographic film was reported; images thereon are projected by reflection from a light in front of the film. In the field of deposition of metals on surfaces are the following: direct covering of iron surfaces with lead deposit, production of a very thin adherent nonporous coating of silver on steel, and metal deposition on plastics.

India

Other countries besides those already mentioned are industrially less developed and their tasks have been not so much to invent new methods and evolve new products as to adopt the already existing approved methods for the production of articles and chemicals within the country with indigenous raw materials.

India is not yet industrialized in the same sense in which the achievements of the countries mentioned in the preceding pages have been traced. Indian industrial developments in 1938 are very meagre when compared with others. Our problem in India is not yet so much to produce the novelities but to develop the key industries first. Serious efforts should be made to reproduce the well known approved standard methods used in other countries. The work will not be so easy as it may seem at the first sight. For, besides, following the description of a method as found in the literature there are plenty of other details which can only be revealed by careful observation and work on similar plans. For economically carrying out a process on a large scale there should be proper initial scrutiny for selection of site, the capital cost, the layout, the maintenance charges, the trifling technical details etc. The

intelligence, knowledge, labour, and skill required for the purpose are not in any way less, and perhaps more, than that demanded by ordinary laboratory research work. The scientists and the 'technicians' run parallel with each other in their activities and the need for a 'cadre' of the latter is very urgent in our country. We have a large number of capitalists and also the scientists in our country are not very few. But they lack in the necessary qualities and aptitudes possessed by their prototypes in the Western industrial countries. There should be a better understanding between these two classes and the relation should be friendly and at the same time businesslike. Quite often 'amateur' capitalists seek and find inadequate advice gratis from scientists, following which the business comes to grief and then the blame is laid on the scientists as a whole. No industrial advice unless paid for and put in details after laborious study can be expected to be endowed with a full sense of responsibility.

In Western countries preliminary work of industrial developments are carried out in the following four types of organizations: (*i*) Government departments and research institutions, (*ii*) Private limited companies who have under their employ well known industrial chemists, chemical engineers, engineers, and scientists at the head and possessing laboratories with semi industrial scale equipments, (*iii*) Research departments of big industrial concerns kept apart from the manufacturing side, where apparently theoretical research work of very high order is also carried out, and (*iv*) Laboratories of universities and other educational institutions. Here problems are definetely stated and the solutions, if carried out, are also given in every detail.

In the United States alone, in 1938, $180,000,000 dollars were spent for industrial engineering research of all kinds. The industrial laboratory personnel has increased from about 6600 in 1920 to approximately 44,000 in 1938, and there are now 1700 such laboratories in operation. The same conditions prevail in Germany as well. Great Britain, though late in the field, has been organising research laboratories in a more systematic manner on the same line, specially after the last Great War.

In India the industrial research laboratories were not in existence till very recent times when the Government started a nucleus in a step motherly fashion Recently however, there are indications of the proper assessment of the value of research by our industrialists. No proper industrial survey has been made of the raw materials available in the country, either under the earth or on the surface. Geological, botanical and forest departments of the government are not very particular with definite industrial statements and proposals. More activity is required to accelerate the speed. Or should we practise the Gandhian philosophy of life and living and be content. But living such a life, though may be desirable to many is well nigh impossible. unless we can isolate ourselves completely from the rest of the world.

Medicine and Public Health

Mechanism of Anti-Malarial Drugs

The Malaria Research Unit at the London School of Hygiene and Public Health is busy with the study of the chemotherapy of malaria and the biochemical mechanism by which anti-malarial drugs bring about their effects. It seems that the presence of a combining group of basic nature in the molecule of the drugs, either natural *e.g.*, quinine and other cinchona alkaloids or synthetic *e.g.*, atebrin and plasmoquin endows them with therapeutic importance. The strength of this group (or groups) has been gauged by measurement of dissociation constants of a number of known anti-malarial drugs and other bases. It is of interest that the remaining portions of the molecule need not be of the benzene ring type as in quinine but, may be of the alphatic carbon chain type, provided that it contains sufficient carbon atoms to make it more effective. The effectiveness of the drugs has been further found to be related with their property of inhibiting enzyme action. But the observation of this inhibiting effect under *in vitro* conditions has been just found to be only a parallel phenomenon with the therapeutic effect and no inter relation between the two has been established so far.

Manufacturing Pharmacy

In a lecture before the Bengal Pharmaceutical Association, Dr A. G. Brocke traced the history of manufacturing pharmacy with a special stress on the conditions in Germany. He said that the laboratories of the alchemists were instrumental in furthering knowledge on chemical substances such as arsenic, antimony and mercury compounds which ultimately found their way into the materia medica. Eventually out of the alchemists of old, the profession of apothecaries developed who were the fathers of the modern chemico-pharmaceutical science. When the apothecary, Sertuerner, isolated the alkaloid, morphia, from opium in the year 1804, investigations into the active principle of drugs received a fresh impetus. Shortly afterwards the apothecaries took up the commercial manufacture of a number of medically active vegetable substances with great success. Alkaloids such as narcotine, strychnine, emetine, cinchonine, quinine, theobromine, etc., were manufactured on a large scale. But all these preparations were derived from their natural sources and only in the later part of the 18th century the first pharmaceutical synthetic product came into existence. The process of investigation was hastened by the discovery of the aniline dyes by Perkins. The discoveries of the anti pyretic properties of anti-febrin by a mistake of a dispensing chemist led to the synthetic production of Phenacetin in 1887 and its manufacture on a large scale by the pharmaceutical works of Bayer. Other products which have become household remedies by now were evolved side by side *e.g.*, aspirin and antipyrin. The latter preparation was discovered by the famous chemist Knorr of Jena and ultimately presented to the world in a more active and less toxic form as Pyramidon (more commonly known as amidopyrin).

According to the speaker, the era of chemotherapy was marked by Paul Ehrlich's discovery of salvarsan for the treatment of syphilis. It meant enormous amount of enterprise to finance these discoveries and carry through the necessary clinical tests on a large scale to ascertain the therapeutic value of salvarsan. Nowadays in western countries syphilis is picturesquely called 'a dying disease,' and it is due to the genius of the inventor of salvarsan and to the energy of manufacturing pharmacy in evolving the discovery on practical lines for the benefit of mankind. The rapid progress of medico-pharmaceutical research in the last years is best illustrated by the discovery of the synthetic malaria products, atebrin and plasmoquine and more recently still by the invention of Prontosil and related sulphona-

mide compounds against streptococci the causal organisms of puerperal fever and a number of other serious and frequently fatal disease. Although Prontosil was patented in 1932 it was not until February 1935 that Domagk, the inventor, published his experimental results concerning the effect of Prontosil in animals.

At the end of his lecture Dr Broeke remarked that it would not have been possible to achieve success by the pharmaceutical profession but for the systematic training given to the students in this branch of science on the universities. Tradition and education for independent research is vigorously kept alive and the spirit of co-operation with medicine and related branches of science furthered by mutual discussions on pressing research questions.

Planning Diets

The Health Bulletin on *The Nutritive Value of Indian Foods and the Planning of Satisfactory Diets*, a second edition of which is just brought out, will make it easy to plan diets. Data have been collected about the composition of some 250 food-stuffs and the publication is a part of the move to popularize the results of nutrition researches. The Bulletin gives caloric requirements and standards suitable for the various age and sex groups in India. Protein, fat, and various vitamins and minerals are also dealt with, with special emphasis on the minimum requirements of each.

There is a long list of diseases, common in India, due in some way or other to dietetic causes. Such are: beriberi, certain anaemias of pregnancy, keratomalacia, osteomalacia. Besides these, states of malnutrition which fall short of serious disease are widespread and very seldom receive any attention. A well-balanced diet is essential if growth and development are to take place normally. The frequency of minor ailments in school children can be removed by improving the diet. But well-balanced diets are in general more expensive than deficient ones. It is, however, possible to make effective improvements with little increase in cost, if information about protein, fat, carbohydrate, calcium, phosphorus, iron, calories and vitamins, is known.

Human beings, and particularly children, cannot thrive at their best on a diet largely composed of cereals such as rice, millet, etc., and insufficiently supplemented by other foods. To make good the deficiencies of such a diet, they must consume fair quantities of foods, like milk, green vegetables, eggs, fruits, etc. These are sometimes known as the "protective" foods, since they are rich in proteins, vitamins and mineral salts, and protect the body against the ills which result when the diet is largely based on less nutritious foods, such as milled rice. Cod liver oil which is very rich in vitamins A and D, may be classed as the most valuable "protective" food.

In drawing up a new diet schedule, or in assessing the value of an existing schedule, it is essential to know whether enough food is being provided. It might be thought that it is easy enough to discover food deficiency, for such deficiency must cause hunger. But experience has shown that human beings can adapt themselves, at a low level of vitality and with their powers impaired, to an insufficient ration, and scarcely realise that they are under fed. The nutrition worker, in setting up standards of food requirements, ignore this remarkable faculty of the body to adapt itself to semi starvation. His standard of food intake implies full satisfaction, enough to enable human beings to lead an energetic life at a reasonably high level of working capacity.

There are, of course many kinds of public health nutrition work besides the planning of adequate diets. The task of the nutrition worker is often to make special additions (*e.g.*, milk, cod liver oil, various vitamin-rich preparations) to an ansatisfactory diet rather than to plan the whole diet afresh. Infant feeding is a subject demanding special knowledge and training. But in all branches of practical dietetics the fundamental principles involved are the same, and an understanding of them is essential for successful work in this field

Indian Journal of Pharmacy

We have on our table the first issue of this quarterly journal devoted to the science and practice of pharmacy, in all its branches, in India. A strong editorial board has been formed with Prof. M. L. Schroff of the Benares Hindu University as the chief editor. The United Provinces Pharmaceutical Association has been mainly responsible for the publication of this journal.

The chaotic condition of the drug trade and industry in India is nowadays receiving more attention

from persons working in pharmaceutical chemistry and also from those interested in the progress of pharmaceutical industry in India. There is absolutely no machinery in this country to control the import, manufacture, storage, and sale of drugs in India. As a result, we are helplessly at the mercy of unscrupulous manufacturers and distributors who are having a lucrative trade in understrength, misbranded and spurious drugs. In other civilised countries in the world, two distinct sections work for the healing art, one dealing with the diagnosis of disease and the prescription of suitable remedies, and the other concerning itself mainly with the preparation and distribution of the remedies. For the latter section, there are well recognised courses of study at the Universities in other countries but in India it has hitherto been neglected with the result that the dispensing of drugs is done by persons mostly ignorant of the pharmacological action of poisons and their doses. The Benares Hindu University is the only university in India which has included pharmaceutical chemistry as one of its subjects for the degree examination in science and for the institution of the degree of Bachelor of Pharmacy. The need for a high standard in teaching and control of drug manufacture was long ago emphasised by the Chopra Committee, but the universities and the different provincial governments are still to be active about it. It is stated that United Province Government have decided to institute a diploma course in pharmacy. The United Provinces have to be congratulated on their wise decision and it is hoped that the other provincial governments will follow suit.

The Journal contains some very useful articles on pharmaceutical chemistry and useful notes and news gleaned from various sources. We congratulate the editorial board for inaugurating this useful publication and we hope their efforts will successfully urge towards bringing about the much-needed reform. In Bengal also the Bengal Pharmaceutical Association and their organ, *Indian and Eastern Chemist* are doing their bit to this cause and as has been reported earlier in these pages, the expected report on the foundation of a College of Phrmacy which will be possible due to the munificence of Dr Ankelsaria and help by the Bengal Government is nearing completion.

Vitamins in Modern Medicine

Amiya Mukherji

Biochemistry marks the progress of modern medicine and during recent times, the most important and largest amount of work in this branch of science has been done with vitamins, hormones and enzymes. It is particularly interesting that all of them belong to the same category and are required in minute quantities for the proper functioning of the body. They are now known to be of definite chemical entities and many of them have been isolated and prepared in a chemically pure state. Some of these augment the action of others while a few others oppose and it is by their balanced action that the proper functioning of the body is controlled. In diseases this balance is disturbed and this disturbance may be brought about by extrinsic and intrinsic causes. In our daily life we get all our hormone and enzyme requirements from our various glands and tissues but the vitamins are mainly gathered from outside. Some animals, however, can prepare some of their own vitamin supply to a certain extent. It is well known for example that rats do not require external supply of vitamin C and provide its own requirements of the vitamin. The interrelationship between the vitamins, hormones and enzymes is a complicated one and only a part of their nature has been revealed to us. In this paper we would limit ourselves to the study of the vitamins with special reference to their clinical applications.

It is well known that we require vitamin in our everyday life and if they are not taken in requisite

amounts certain diseases appear which may be either of an acute or chronic nature. The chronic forms are more widespread and less recognised than the acute forms, not only in India but throughout the civilised world. No rigid rule however, can be defined about the quantity of each vitamin that must be taken by each individual for normal health. It depends much on the constitution, vocation and habits of the individual. In the case of vitamin B complex, Cowgill has shown clearly that the quantity to be taken depends on the basal metabolism of the individual. From experiences in various clinics and laboratories, it is believed to hold good for other vitamins as well. The vitamin B requirements of rats are many times greater than human requirements, weight per weight, while it is also clear that weight per weight the basal metabolism of rats are much more than human beings. The present author has carried out investigations which show that the function of the vitamins is also directed to neutralise the toxic substances that are present in the body, either as the result of the metabolism or introduced from outside. If this is the case as has been proved both in experimental animals and human beings, it is easy to understand why the vitamin requirements are normally dependent on the basal metabolism of the animal. According to Stepp, Kuhnau and Schroeder an adult person requires on the average the following amounts of the different vitamins:

Vitamin A in the form of carotine minimum 1 mgm, optimum 3 5 mgm (not exactly known).

Vitamin B_1 (aneurin) minimum .25 mgm – .5 mgm, optimum 1 2 mgm..

Vitamin B_2 (lactoflavin) minimum 1 mgm, optimum 2 3 mgm. The minimum requirements of other factor of the vitamin B complex are not known but it should be contained in the same quantity of yeast as would contain the minimum aneurin requirement and so should be contained in 3 6 gms of yeast and the optimum amount in 12 24 gms of yeast when the aneurin content is about 80 γ per grame of the yeast.

Vitamin C (ascorbic acid) 5 mgm crystalline acid for children and for adults 20 –50 mgm of the acid (the optimum quantity is almost of the same order).

Vitamin D (D_2) infants and little children .002 mgm crystalline calciferol, optimum requirement and for rickety children .01 mgm calciferol. The minimum requirements for adults are not known but will not be much higher.

Vitamin E—Quantity required is not known. The absolute quantities of the vitamins can be converted into international units as follows: 1 mgm carotine 1666 I. U., 1 mgm aneurin 500 I. U; lactoflavin No I. U.; 1 mgm ascorbic acid 20 I. U.; 1 mgm calciferol 40000 I. U.

There are cases where symptoms appearing due to absence of some vitamin are exaggerated if another vitamin is supplied in excess or in other cases the latter's action is accentuated. These are cases of antagonism of vitamins. Similarly presence of certain vitamin favours the action of certain other vitamin or vitamins and is known as synergism. However at the normal physiological level all the vitamins are acting harmoniously and no question of antagonism arises. Thoenes found in 1933 that in absence of vitamin A the action of vitamin D is exaggerated and similarly Gross and Selbeck in 1933 showed that the effect of the excess of vitamin D is damped by vitamin A. The reverse also holds good as in the absence of vitamin D the action of vitamin A appears exaggerated (Bomskov 1933). Rickety conditions in rats are made worse by administration of vitamin A (Tabore). But these occurred under extreme controlled conditions and in the normal physiological level they help each other in their action whence it is better to give both the vitamins A and D in the form of, say, codliver oil instead of one of them alone. There exists also an antagonism between the vitamins A and B complex. Vitamin A given in large doses in absence of vitamin B_1 (aneurin) would stimulate the condition found associated with the vitamin B_1 (aneurin) deficiency (Schemmert and Rau). It is also known that vitamin B complex weakens the effect of large amounts of vitamin A but according to Stepp, this antagonism occurs only in the presence of vitamin C. If vitamin C is given in adequate amounts when giving an excess of vitamin A the effect of the excess of vitamin A is not noted. (Wendt and Schroeder). With guineapigs having a low vitamin C diet administration of codliver oil is injurious. Effect of excess of vitamin D is neutralised by a liberal supply of vitamin B complex in the form of yeast etc., (Holson Bell, Jusatz). Sanchez, Rodiguez and Morros Sarla had shown that the vitamin D has an antiberiberi effect with pigeons having vitamin B_1 free diet. Han Young Oh and also the present author found calcium to be of good therapeutic value in beriberi. It therefore

follows that the antiberiberi effect of vitamin D. is concerned with the calcium metabolism, probably by stimulating the parathyroids. It has also been found that in animals poisoned with guanidine bodies and treated with aneurin there is a large increase of calcium in the liver and muscles compared with the untreated animals and this fact is very significant in this connection. There is no known work on the relation between vitamins B_1 and C. The writer did some work in this direction without any positive result, but probably there is some interrelation between the two and he, in 1938, showed that the different factors of the vitamin B complex act in synergism.

Interrelation between vitamins and hormones though very important, our knowledge about them is far from adequate. In addition to the observation, that vitamin D stimulates parathyroids and possibly also thyroids as it has been found that vitamin B_1 (aneurin) increases the calcium content of liver and muscles in rats poisoned with guanidine and methylguanidine, it appears that aneurin might also be stimulating the parathyroids. Very interesting works of Bruno Minz and Rene Agid show fairly well that aneurin presents identical biological properties with that of the sensitizing substance of the excited nerve trunk, which is acetyl choline in the case of parasympathetic and adrenaline like substance in the case of sympathetic and depends on the concentration of the aneurin present. In the concentration when aneurin behaves like stimulated sympathetic nerve trunk it should be stimulating the suprarenal, thyroid and parathyroids. But at the same time it has been demonstrated that aneurin as also vitamins A and C neutralise the toxicity of excess of thydroxine. The disturbances due to excess of vitamin A as also the growth factor of A are lessened by thyroxine. There is however, synergism between vitamin C and thymus gland hormone, for the removal of the thymus gland increases the severity of the scorbutic symptoms in the guineapigs.

The classical uses of vitamins A, B, C, D, in aeropthalmia, beriberi, scurvy and ricket are too well known to be written again. But there are a number of other diseases where vitamin treatment is not only indicated but possibly the best treatment, whether alone or in conjunction with other usual treatments. The following account is far from being a comprehensive review of recent literature of vitamin therapy but gives mainly in brief some experiences from various clinics and laboratories in India and abroad.

Vitamin A is used successfully in milder forms of night blindness, superficial keratitis, and keratomalacia. It should be used in cases of neuritis along with aneurin or vitamin B complex. In exopthalmic goitre (Grave's or Basedow's disease) since the vitamin A is used up in much larger quantities by the system its use is indicated and results have been found to be good, but simultaneous use of aneurin and vitamin C is useful, since both of them neutralise the toxicity caused by excess of thyroxine, and always aneurin should be used along with the vitamin A for this purpose (30 drops of vogan thrice daily for vitamin A). From the immunological aspect vitamin A helps the formation of antibody and has bactericidal power; it is specially true with catarrhal infections, such as pneumonia, grippe, puerperal fever etc., and also in hay fever and bronchial asthma. It is all the more useful for children. Codliver oil ointment (I) or preparations used locally in wounds helps the formation of granulation tissue. It is also useful in severe burning, osteomyelitis, bacillary osteoarthritis, perianal fistula, and cutaneous tuberculosis. In achlorhydria gatrica vitamins A and aneurin are very useful. Administration of large doses of vitamin A has been recommended by Rehn as a prophylactic measure against liver damage. With stone in the urinary bladder or kidney and ureter vitamin A should be given a trial. Experimentally and in some clinical cases it has been found to be effective in America and Holland.

The clinical use of vitamin B complex or aneurin has been much less than it deserves. The present writer has found with experimental animals that aneurin, lactoflavin, and a heat labile factor of the B complex (B complex aneurin and lactoflavin) can neutralise at least certain strong poisons *in vivo* including guanidine bodies which are normally produced in small quantities in animal metabolism. In clinical practice on two occasions persistent vomiting of pregnancy was treated with aneurin when other methods had failed with excellent results. In one case Betabion of Merck was adminstered 10 mgm daily orally at the first instance for 10 days and the same was repeated when it reappeared for the second time in a milder form and after this daily 1 mgm was given for a period of 30 days. In another case where vomiting was as much as 80 times a day but which seemed to be more of neurotic type it was given intramuscularly 2 mgm on

the first day, 6 mgm on the second day and 3rd day and 10 mgm on the 4th day after which frequency of vomiting was markedly lessened and kept well from that time. It was not necessary to give glucose intravenously. As the vitamin B complex acts better than the individual factors alone, specially when used to treat toxic conditions, it should be given as such and good quality yeasts will be found quite suitable for this purpose. In acute cases, however, as the vitamin B complex is not available in pure form, aneurin and lactoflavin is to be used. But then also the vitamin B complex of Bayer issued in ampoules may be tried which has been found to be effective. Largest amount of vitamin therapy has been undertaken in German-speaking countries and Prof. Stepp in Munich and Prof. Vérzar in Basle are the leading men in the field. In all kinds of neuritis—alcoholic, gastrogenic, metabolic, diabetic, pregnancy, postinfections, toxic, traumatic, and optic—aneurin in adequate amounts and continued over a reasonable time according to the severity of the disease has been found to give invariably good results. It has also been used with complete or partial success in neuralgia including sciatica when not due to organic causes, spastic paralysis, tabes, facial paralysis, spastic paraplegia, multiple neuroma, syphilitic polyradiculitis, and herpes zoster. In other cases, such as chronic gastric ulcer, constipation due to atonia of the intestinal muscle etc., aneurin give very good results. There are many other cases such as diabetes and certain types of anaemia where its use proved successful in some instances.

The proper selection of vitamins for diseases amenable to vitamin treatment requires considerable experience. But if the practitioner uses the vitamin B complex or aneurin in the cases under his treatment, no ill effect will be observed. The vitamin B complex has been found to be toxic at stage whose level is many thousand times greater than the therapeutic doses. Only one contraindication of aneurin is that it should not be given in cases of zeropthalmia, specially if the patient is having at the same time a liberal supply of vitamin C. Though the different factors of the vitamin B complex are indicated in different diseases yet for a general practitioner who is not specialising in the line the vitamin B complex may be used in the form of yeast in quantities of 10-50 gms a day. In the case of lactoflavin the price is exorbitant and, moreover, the onl way of administering it, is also in the form of yeast. The other factors of the vitamin B complex are not in the market except the vitamin B complex of Bayer.

The greatest value of vitamin C (ascorbic acid) besides its antiscurvy property lies in its use in bacterial infection, most important of which is possibly diphtheria. Many workers have found it to be effective both in experimental and human diptheria. It also neutralises the diphtheria toxin *in vitro*. Only in one ineffective *in vivo*. Further, ascorbic acid increases the single instance one worker has found ascorbic acid to be natural resistance. In pneumonia the amount of the ascorbic acid required is much greater than in normal. The use of ascorbic acid is indicated in many of the diseases accompanied by haemorrhage, both external and internal. It has given encouraging results in several instances in haemoptysis in pulmonary tuberculosis. Ascorbic acid is responsible for the proper formation of the soft part of bone and teeth and it gives good results when they are at fault. In spongy gums it is useful and also in allergic conditions like vitamin D.

Vitamin D is indicated in rickets, osteomalacia, tetany, allergic conditions, tuberculosis, fluor albus (use vigantol), eczema in children (use vigantol ointment) and radium poisoning. Vitamin D should also be used in any toxic condition where calcium treatment is indicated such as carbontetrachloride poisoning.

Vitamin E is at present known only as antisterility vitamin. Further researches it is hoped will throw much light on the treatment of cancer with one or more vitamins.

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RESEARCH NOTES

A New Type of Microrespirometer

Manometric methods, involving the use of the respirometers of Barcroft or Warburg, are among the most useful and widely applied technique in the field of biochemistry. These and similar other instruments are capable of measuring gas exchanges of not less than about $30\mu l$ hr., so that 5 50 mg. of tissue are normally used. As there is a need for methods of measuring much smaller gas changes, several instruments capable of measuring O_2 uptakes of $1\mu l$/hr., or less have been described during the last decade. A miniature Barcroft Warburg type of instrument has been described by Stefanelli. There are others in which the respiration chamber is connected to a horizontal length of capillary tubing the movements of a drop of fluid in the latter indicating the changes in volume. An entirely different method described by Linderstrom-Lang and extended by Needham and Boell is based on the principle of the Cartesian diver.

While each of these types possesses certain advantages, it appears that none of them in their present form can carry out on micro-scale all kinds of measurements which can be done on a larger scale with the Barcroft or Warburg apparatus. Heatley, Berenbhum and Chain *Biochem. J.*, *33*, 53, 1939) describe an apparatus which employs a principle which has so far not been used in a respirometer. This apparatus is capable of measuring uptakes and out puts of about $1\mu l$/hr., with an accuracy, at least as great as that. of the Warburg apparatus. Its special feature is that it can be assembled at one temperature and used at a widely different one; it can be filled with any gas mixture, and two or more separate fluids contained in it can be mixed at any desired time during an experiment. The fact that it can be used under sterile condition is an additional advantage.

The respiring material rests in a completely closed chamber, one wall of which consists of a thin sheet of mica. Two plane mirrors are attached to the latter, and when the volume of the gas in the chamber changes, the mica will bulge with the result that the mirrors will tilt in opposite directions. By applying a positive or negative pressure to the outside of the mica membrane, the latter may be brought back to its original position, a simple optical system being used to detect when the mirrors are in the same place. Knowing the volume of the gas space and the change in pressure in it, the amount of gas absorbed or given out may be calculated.' The authors claim that all estimation which can be determined manometrically in the Warburg apparatus can also be carried out in this microrespirometer, the amounts which can be estimated being 200 times smaller. No special skill is required in its manipulation and during actual experiment 6 readings can be taken in 5 minutes.

H. N. B.

Colorimetric Determination of Organic Carbon in Soils

The usual method for determining accurately the organic carbon content of a soil is to find out the total carbon by a combustion method and to deduct from that the percentage of inorganic carbon separately determined. The entire procedure requires a very long time and an elaborate arrangement. The rapid method of wet combustion which depends on the amount of chromic acid reduced by soil organic matter is rather unsatisfactory in that it accounts for only a certain fraction of the organic carbon and the conversion factor differs with different soils. Recently Emmert has developed a

method of rapid determination of organic carbon in soils depending on the matching of the brown colour which is formed when organic matter is heated with 50% (by volume) sulphuric acid (*Soil Science*, *46*, 397-400 1938). In this method 0.25 to 2 gm. of soil is heated strongly in a hot plate in 25 c.c. of 50% (by volume) sulphuric acid in a 200 c.c. Erlenmeyer flask until foaming ceases, white fumes starts coming off profusely, and acid just starts to condense on the sides of the flask. The mixture is cooled and made up to 25 or 50 c.c. with 50% H_2SO_4. The solution is shaken well, poured into a test tube and allowed to settle. As soon as the supernatant liquid is clear, the standard is compared in a colorimeter. If immediate reading is desired a plug of glass wool may be placed in an appropriate funnel and the solution decanted from the soil residue as much as possible on to the filter. Considerable filtrate should be allowed to run back into the original flask which should be poured back until the solution is clear. For the preparation of the standard 5 c.c. of 0.25 p.c. pure anhydrous glucose solution should be heated to the same point with 25 c.c. of 50 p.c. (by volume) H_2SO_4. The mixture is cooled and made upto exactly 20 c.c. with 50 p.c. H_2SO_4. One cubic centimeter contains 0.25 mgm. of carbon. If 0.125 mgm. is desired for low C soils, the mixture is diluted to 40 c.c. with 50 p.c. H_2SO_4.

Emmert has compared the total organic carbon of a considerable number of soil samples, determined by the furnace combustion method and by the colorimetric method. The latter is found to give slightly higher results in nearly all cases, but the differences are never large. The rapid colorimetric method therefore, appears to be fairly accurate for ordinary work and is certainly worth giving trials with various soil types at different places.

Metabolic Activity of Small Amounts of Surviving Tissue

For histochemical studies it is necessary to measure the metabolic activity of small amounts of surviving tissues and of cell suspensions. With the aid of their newly devised microrespirometer, Berenblum, Chain and Heatly (*Biochem. J.*, *33*, 68, 1939) studied the metabolism of minute fragments of surviving tissue and describe the special difficulties that arise in such studies.

The authors recommend that the area of tissue slice to be used in the microrespirometer should be approximately 0·5 to 8·0 sq. mm., the size depending upon the metabolic activity of the particular tissue used so as to give a gas exchange of not less than 0·3 μl and not more than 3·0 μl per hour.

After describing in detail the technique of cutting and preparing small tissue slices suitable for use in the microrespirometer, they prove experimentally that diffusion of O_2 through the tissue was adequate, provided the slices were cut reasonably thin.

Comparative experiments on the O_2 uptake of liver and kidney slices, carried out simultaneously in the Warburg apparatus and microrespirometer showed reasonably good agreement between the two, both in the presence and absence of oxidisable substrates, so that under suitable conditions, the effects of diffusion and of damage of the tissue due to cutting are negligible.

The metabolic values, quoted in the literature for slices of tissue, have hitherto been calculated in terms of dry weight. Since on this standard no allowance is made for inactive elements in the tissue the values obtained can not be expected to bear any relation to the true metabolic activity of the cells contained therein. From general considerations of the physiological functions of these organs and from their respective blood supplies in the intact body, the order of their metabolic activities would seem to correspond much more closely to that given by the nucleic acid standard than that based on dry weight.

After discussing the various methods for determining the amounts of metabolizing material, they recommend that for tissues containing large amounts of inactive material *e.g.*, skin, thyroid, necrotic tumour, tissue, culture etc., the metabolic values should be expressed in terms of nucleic acid phosphorous content. A convenient method for the estimation of nucleic acid phosphorous in small amounts of tissue is described. This method gives reasonably accurate results with amounts of nucleic acid phosphorous down to 0·2 μg respresenting approximately 1·8 μg of nucleic acid.

H. N. B.

Auxin Transport in Plants*

The mechanism of polar transport of auxin has recently been explained by Went in his "*Botanische Polaritäts theorie*", the idea being that the dissociated anion of auxin is transported longitudinally in the plant as a result of the inherent electrical polarity of the organ in question. W. G. Clark in his series of investigations on Electrical Polarity and Auxin Transport (*Plant physiol.* Vol. 12, Nos. 2 and 3, 1937; and Vol. 13, 1938) has studied the question in detail and has demonstrated the apical negativity and the basal positivity of the organ in question, but polar heteroauxin transport in Avena coleoptiles may be specifically abolished by using certain lysins as one part of sodium glycocholate in 100,000 parts of water without there being any change in electrical polarity, respiration, semi-permeability, growth by cell elongation or protoplasmic streaming. Therefore electrical polarity expressed in terms of inherent potential differences has no apparent causal relation to polar auxin transport. Thus an interesting and promising field is offered for further investigations into the mechanism responsible for polar transport.

B. K. K.

Element 43—Masurium

This element was discovered as early as 1925, along with rhenium, by Noddack, Tacke and Berg in the X-ray spectra of concentrates from platinum ores and some other minerals (*Z. angew. Chem.*, *38*, 1157, 1925; *Naturwiss.*, *13*, 567, 1925). The present scanty data on masurium, in contrast with that on rhenium is due to the extreme scarcity of the element. The highest concentration claimed to have been obtained by the discoverers is of the order of 0·2—1% Ma in a sulphide concentrate from columbite.

An interesting method of studying some of the chemical properties of the element has recently been developed by artificially producing a radioactive isotope of the element and then studying its properties by using the activity of the isotope as indicator. A plate of molybdenum was exposed for some months to a strong deuteron beam (along with secondary neutrons always generated) in the Berkeley cyclotron at Professor Lawrence's laboratory in the University of California. Six weeks were allowed for any short-period induced activity to decay, after which the plate continued to show a strong activity due to slow electrons.

Usual types of nuclear reactions under conditions described indicate the possibility of formation of Zr, Nb, Mo and Ma; the first and last elements by neutrons (reaction type n; α) and deuterons (type d; n) respectively; while both neutrons and deuterons can give rise to isotopes of niobium (d; α or n; p) and molybdenum (n; or d; p). By dissolution of the plate in acid and analytical separations in presence of small quantities of Zr, Nb, Re, Mn and Mo ((already present), Perrier and Segrè showed in an earlier paper (*J. Chem. Phys.*, *5*, 712, 1937), that the active body, formed by nuclear disintegration, concentrated in the rhenium-manganese sulphide precipitate, thus ruling out the possibility of the active isotope being a member of the fourth, fifth and sixth groups. It was therefore reported by the said authors that the active body is an isotope of element 43, masurium, formed by a nuclear reaction of the type d; n by deuteron bombardment on molybdenum.

Quite recently (*J. Chem. Phys.*, *7*, 155, 1939), the same authors have devised a very simple and rapid method of extracting this isotope in a concentrated form, which consists in boiling the molybdenum plate with ammonium hydroxide with occasional additions of hydrogen peroxide. The active body, formed exclusively on the surface of the plate which was exposed to the beam of deuterons, goes into solution, presumably in its maximum valency state, *viz.*, seven, with a little of molybdenum, which is removed by precipitating with 8 hydroxyquinoline. The sulphide of the isotope is then co-precipitated with rhenium sulphide.

The activity of this isotope has been of service in studying some physical and chemical properties of masurium. The precipitate of rhenium sulphide from 10N HCl solutions carries down very little of the activity, indicating the greater solubility of masurium sulphide in strong mineral acids, expected

*The note on Auxin Transport in Plants was published in our April issue, but as there were unfortunately some anomalies in the text due to the mistake of the Press, it has been repeated in the correct form in this issue.

from its intermediate position between Mn and Re in Group VII A.

Earlier experiments in 1937 already indicated the volatile nature of the oxide like the heptoxides of other seventh group elements. The recent paper embodies results of study of the solubility of the sulphides and the permasurate in water, of the sulphocyanide in ether, and of precipitation experiments with alkaline stannous chloride.

The two papers from Italy beautifully illustrate the possibilities of the cyclotron instrument, which enabled the workers to study the properties of an element before isolating it in weighable quantities.

J. G.

Nuclear Reactions of a New Type

Hahn and Meitner as well as Curie and co-workers showed that by bombarding thorium with neutrons synthetic radioelements were formed. These were isotopic with either Ra, Ac or Th and seemed to follow the disintegration scheme shown below.

$$\mathrm{Th}^{232}_{90} + n^{1}_{0} \longrightarrow \mathrm{Th}^{233}_{90} \begin{cases} \dashrightarrow \mathrm{He}^{4}_{2} + \mathrm{A}^{229}_{88} \longrightarrow e + \mathrm{B}^{229}_{89} \dashrightarrow \bar{e} + \mathrm{Th}^{229}_{90} \\ \qquad\qquad (\text{Ra - isotope}) \quad (\text{Ac - isotope}) \\ \longrightarrow \bar{e} + \mathrm{C}^{233}_{91} \\ \qquad\qquad (\text{Pa - isotope}) \end{cases}$$

Reactions with uranium were still more complicated. However, as a result of the work of Fermi and his collaborators and of Hahn, Meitner and Strassman the following three series were generally recognised among the disintegration products of uranium.

$$(\mathrm{A}) \quad \mathrm{U}^{238}_{92} + n^{1}_{0}\left(\begin{smallmatrix}\text{fast or}\\ \text{slow}\end{smallmatrix}\right) \longrightarrow \mathrm{U}^{239}_{92} \xrightarrow[10\,\text{sec}]{\beta} \text{Eka Re}^{239}_{93} \xrightarrow[22\,\text{min}]{\beta} \text{Eka Os}^{239}_{94}$$
$$\xrightarrow[59\,\text{min}]{\beta} \text{Eka Ir}_{95} \xrightarrow[66\,\text{hr}]{\beta} \text{Eka Pt}^{239}_{96} \xrightarrow[2.5\,\text{hr}]{\beta} \text{Eka Au}^{239}_{97}$$

$$(\mathrm{B}) \quad \mathrm{U}^{238}_{92} + n^{1}_{0}\left(\begin{smallmatrix}\text{fast or}\\ \text{slow}\end{smallmatrix}\right) \longrightarrow \mathrm{U}^{239}_{92} \xrightarrow[40\,\text{sec}]{\beta} \text{Eka Re}^{239}_{93} \xrightarrow[16\,\text{min}]{\beta} \text{Eka Os}^{239}_{94}$$
$$\xrightarrow[5.7\,\text{hr}]{\beta} \text{Eka Ir}^{239}_{95}$$

$$(\mathrm{C}) \quad \mathrm{U}^{238}_{92} + n^{1}_{0}(\text{slow}) \longrightarrow \mathrm{U}^{239}_{92} \xrightarrow[23\,\text{min}]{\beta} \text{Eka Re}^{239}_{93} \dashrightarrow$$

The transuranates as these products were called had atomic numbers ranging from 92–95, close to that of the parent nucleus U_{92}.

More recently Curie and Savitch detected an active body of 3.5 hours life amongst the other products of uranium bombarded by neutron. Hahn and Strassman who conducted a very careful search for this product, found that at least three bodies were produced in this reaction which could be completely separated from the transuranates. These were separated with barium and were at first thought to be isotopes of radium. Attempts were made to concentrate the portion richer in radium by fractional crystallisation. However the method failed to show any change in activity among the different fractions, although other radium isotopes like MsTh, ThX always showed an increased activity in the earlier fractions.

Hahn and Strassman have therefore suggested that isotopes of barium (charge number 56) are produced by the bombardment of uranium with neutrons. This is the first instance where a heavy nucleus like that of uranium splits into two halves of roughly equal mass. If one of the two halves is barium the other may be krypton. After division both halves probably decay by emitting β rays in order to readjust the high neutron proton ratio and form a stable light element. Thus barium follows barium lanthanum cerium chain while krypton decays to zirconium *via* rubidium, strontium and yttrium. In the light of these results it seems highly probable that thorium also breaks up similarly to lighter elements.

Frish, Fowler and Dodson as well as Meyer, Roberts and Hafstad have obtained further confirmatory evidence for the correctness of the above hypothesis. When bombarding uranium and thorium with neutrons they observed particles causing an intense ionisation in the chamber. From the intensity of ionisation as well as from the length of the track Frish estimated that the particles must have an atomic weight of more than 70. It has not yet been possible, however, to cause splitting of uranium or thorium nuclei with γ-rays. Attempts to obtain similar effects with other heavy nuclei like those of Bi, Pb, Hg, Au, Pt, W, Sn, or Ag, have also failed.

RESEARCH NOTES

The phenomenon of the splitting of a heavy nucleus fits in well with Bohr's ideas about nuclear structure. According to him a heavy nucleus behaves as a liquid drop on account of the closeness of packing and strong interaction between the consitituent particles. When energy is added to the drop (*e.g.*, by the capture of a neutron) this extra energy is stored in the compound nucleus much in the same way as heat energy is retained by a liquid drop. Some of this excitation energy may by chance be ultimately concentrated in a particle, near the surface and we have the familiar instance of the ejection of an α-particle, neutron or proton. But as an alternative process the excitation may be such that the nuclear surface is "deformed" to a considerable extent. The drop may then split into two fractions, the surface tension being unable to hold it together. The two parts will then repel each other and gain considerable kinetic energies which may also be calculated from the difference in the packing fractions. In the case of uranium the calculated energy of the barium nucleus agrees well with measurements from the ionisation intensity

According to this view, for smaller excitations the fission probability is much less than the radiation probability of the compound nucleus. Hence we do not observe any resonance effects in the fission process though they have been noticed by Hahn, Meitner and Strassman in the alternative process *viz.*, the formation of the radioactive uranium with neutrons of 25 volts energy. But the fission probability increases with excitation much faster than the radiation probability and may even become larger. With fast neutrons the fission cross section becomes about the same for uranium and thorium.

There is, however, a striking difference in these two elements with respect to the fissions caused by thermal neutrons. An effect is obtained with uranium but not with thorium. Bohr has tried to explain this by associating this process with the rarer isotope of U^{235}. If this view is correct U^{236} is formed by neutron capture which will be in a higher excited level than U^{239} and will therefore provide a greater fission cross section.

N.N.D.G.

UNIVERSITY AND ACADEMY NEWS

PROCEEDINGS AND PUBLICATIONS

Indian Physical Society and Indian Association for the Cultivation of Science

(*Calcutta, December, 1938, Indian Journal of Physics Vol. XII Pt. VI*).

A. C. BANERJI and P. L. BHATNAGAR: On the intensity of ionisation in the earth's atmosphere.

A. BALANKESWARA RAO: The spectrum of argon IV.

L. SIBAIYA: On the excitation of Chladni figures.

S. K. BANERJI: On the interchange of electricity between solids, liquids and gases in mechanical actions.

MOHINI MOHAN GHOSH: Dynamics of the piano forte string and the hammer. Part II.

S. K. MITRA, J. N. BHAR and S. P. GHOSH: The lower ionosphere.

Indian Chemical Society

(*Calcutta, December, 1938 J. I. C. S. 15*, 617 653. 1938)

A. MUKHERJI: The vitamin B complex in toxic conditions.

K. MITRA: Nutrition studies in Bihar. Part II. Chemical composition of some local edibles.

T. N. MEHTA AND V. B. THOSAR: The reaction of some aromatic diamines with ethyl malonate.

PRIYADARANJAN RAY AND HARIBOLA SAHA: Complex compounds of biguanides with tervalent metals. Part V. Thiocyanates of chromium biguanides.

N. N. CHATTERJEE AND GIRINDRA NATH BARPUJARI: Spiro compounds. Part V. The formation and trans formation of spiro compounds from 3 and 2-methylcyclohexanones.

B. L. MANJUNATH AND M. S. SHANKARA RAO: Chemical examination of bragantia wallichii (Lour.).

G. V. JADHAV AND D. R. SUKHTANKAR: Inter action of sulphuryl chloride with arylamides of aro matic acids. Part I.

B. L. MANJUNATH AND M. S. SHANKARA RAO: Note on the occurrence of behenic acid in the oil from the seeds of *pongamia glabra*, Vent.

(*Calcutta, January, 1939, J. I. C. S., 16, pp. 1 50, 1939*)

VISHWANATH SHARMA AND SALIMUZZAMAN SIDDQUI: The constituents of *Didymocarpus Pedicellata*. Part II. Comparative studies in the constitution of pedicin, iso pedicin, pedicinin and pedicellin.

H. KRALL: The tautomerism of nitrous acid.

M. K. INDRA: Variation of the cataphoretic velo city of silver halides in presence of different dyestuffs.

MAHAN SINGH: Studies on rotatory power and chemical constitution, Part IV.

BALWANT SINGH AND SOHAN SINGH: Potentio metric studies in oxidation-reduction reactions. Part IV. Oxidation with potassium chlorate.

KUNJ BEHARI LAL AND HANS KRALL: The phenylthiocarbamides. A contribution to the study of the triad -N.C.S.-. Part VIII. The chemistry of Hector's base and attempts towards its synthesis.

P. C. MITTER AND SHYAMAKANTA DE: Studies in γ-ketonic acids. Part I.

UNIVERSITY AND ACADEMY NEWS

H. S. Jois, A. Kappusami and B. L. Manjunath: Isomerisation of benzylidene derivatives. Part I.

Baidyanath Ghosh: Studies on the changes of blood-lipoids of normally fed and vitamin C-deficient guinea-pigs.

Calcutta Mathematical Society

(Calcutta, Bulletin—September and December, 1938, pp 87-167)

R. V. Sastry: A self-reciprocal function.

B. C. Mukherjee: Two cases of exact gravitational fields with axial symmetry.

Haridas Bagchi: Vector theory of non-coplanar forces.

A. C. Chowdhury: Affine rolling of first kind.

Royal Asiatic Society of Bengal

(Calcutta, 3rd April, 1939).

M. L. Roonwal: Some recent advances in insect embryology, with a complete bibliography on the subject.

S. L. Hora: Two new exhibits in the Fish Gallery of the Indian Museum.

Chintaharan Chakravarti: Society's collection of manuscripts of works on the science of warfare in old India.

RESEARCH WORK IN INDIA

The research work carried out during the last session in the department of botany including Kashyap Research Laboratory may be put under the following heads: (*(i)* Systematics, (*ii*) Plant Pathology, (*iii*) Soil Microbiology, (*iv*) Plant Physiology including Ecology and (*v*) Cytogenetics.

In systematics, monographs on Lahore flora, liver-worts, lichens, myxomycetes, diatoms have been published as also serial publications on water moulds and coprophyllous fungi have been made. A large number of papers on algae, specially on blue green algae have been published. Systematic work on liverworts, ferns, algae, fungi is in progress and a monograph on ferns is nearing completion. In plant pathology a very large number of papers, mainly on diseases of economic plants and their control, have been published. Investigation on the 'wither-tip' disease of the citrus in the Punjab financed by the I.C.A.R. has been completed and the report published. Besides investigations on diseases of economic plants work on the investigation of smuts and rusts of the Punjab is in progress. In soil microbiology, publications cover soil algae, soil fungi, soil actinomycetes and soil protozoa. Work on the first three groups of organisms is continuing. In plant physiology and ecology, publications include besides study in the physiology of lower organisms, effect of nutrients on sex in higher plants. At present, work on vernalisation, ecological study of marine algae from Karachi, and ecological study of the plants of the eroded area is in progress. Work on soilless growth has been started as also experiments on growth promoting substances. Studies in physiology of fermentation by fungi and bacteria are also being carried on. In cytogenetics and cytology a number of publications have come out from this department and at present several students are carrying on research work on the same.

Book Review

The Evolution of Genetic Systems *by C. D. Darlington. (Cambridge University Press, 1939). Pp. 149; text figs. 26. Price 10s. 6d. net.*

The title of this book was the title of the last chapter in the first edition of Dr Darlington's text book, *Recent Advances in Cytology*. That chapter was omitted from the second edition. It has now been expanded and the cytological facts which account for the phenomena of genetics are simply and concisely expounded in a handy volume.

This is a lucid and readable resume of much that is set forth in the author's longer work, set down briefly and unhampered by exhaustive series of examples and references.

Genetics is concerned with reproduction. This book contains a clear account of the behaviour and evolution of the visible determinants of heredity in the cell nucleus, *i.e.*, the chromosomes. There are concise descriptions of meiosis, chromosome mechanics and mechanism of genetic crossing-over according to the latest discoveries and system of nomenclature. The evolution of polyploidy, of differential chromosomal complentents by structural changes, of permanent hybrids, of sex inheritance, of sterility and apomixis are traced. The penultimate chapter deals with the manner in which the units of heredity, the genes, act upon the nucleus, cytoplasm and body as a whole. The final chapter surveys the evolution of reproductive systems from the naked gene and also the broader implications with reference to the evolution of species and to the classical theories of Lamarck and Darwin.

There is a bibliography of ninety-one titles and an excellent index. This little book by the world's foremost cytologist will be welcomed by everyone interested in the mechanism of heredity; not only cytologists and geneticists, but teachers, medical men, professional breeders and all members of the public who wish for reliable, up-to-the-minute information on modern "natural philosophy".

E. W. E.

Grimsehl Tomaschek's Lehrbuch der Physik, Vol. I. (Mechanics, Heat and Acoustics); *edited by Prof. Dr. R. Tomaschek. (B. G. Teubner, Leipzig and Berlin; 1938). Pp. 681.*

Grimsehl's text book on physics is so well-known that it requires no introduction. It is extensively used in German universities and Technische Hochschule as the text book on experimental physics. The success of the book has been primarily to Grimsehl's remarkable gifts as a teacher. After his death it has been amplified in the spirit of the original by Dr R. Tomaschek, Director of the Physical Institute of the Technische Hochschule in Dresden and has run into the tenth edition.

The book is written with characteristic German thoroughness. The fundamental principles are always kept clearly before the reader and explained in a pleasant and extremely lucid style. Most up-to-date applications are given and illustrated with figures and photographs which can hardly be surpassed in excellence. Unique illustrations in the chapter on vibration and waves may be particularly mentioned. The exposition of hydro-and aerodynamics is masterly where a very lucid account of the principles of flying is also given.

The book is divided into thirteen sections. The first ten sections covering 411 pages is devoted to the general principles of mechanics. It includes the

principles of units and measurements, different types of motions, the laws of force and energy, statics and dynamics of particles and rigid bodies, law of gravitation, formation and structure of matter, elasticity and rigidity, motion in resistive medium, the behaviour of liquids and gases, hydro and aero-dynamic with an account of flying and the theory of vibrations and waves. The eleventh section deals with the theory of heat, kinetic theory of gases, the principles of thermodynamics with their applications to the construction of machines etc. The last two sections are devoted to acoustics and ballistics and in the appendix tables of the important physical constants are added. The book ends with a chart giving an account of life of the distinguished scientists and their important works.

It is a pity owing to the language difficulty the book will not be of very wide use by students in India. Messrs. Blackie and Sons felt the necessity of an English edition. They translated the seventh German edition of the book and made it accessible to the general body of Indian students. It is difficult to compare the standard of the book with the course of studies in our universities. In general it may be said that the book covers our pass degree course, but in many places goes beyond the pass curriculum. Honours and advanced students will find it useful to give a perusal to the book.

The book is highly recommended to the students who want to have a grasp of the fundamental principles of physics and their applications and Prof. Dr R. Tomaschek is to be congratulated for bringing out this new edition of the book improved and enlarged. The get-up and the printing of the book is excellent.

R. C. M.

GEOLOGY OF INDIA—*by D. N. Wadia. (MacMillan & Co., Ltd., 1939). Price 24 shillings net.*

The first edition of Mr D. N. Wadia's *Geology of India* was published in 1919 and a revised edition in 1926. The new edition under review has been thoroughly revised and brought up to date by the incorporation of results of research since the first edition was published 20 years back. An official *Geology of India* was published in 1887, and a revised edition of it was issued in 1893 by the Geological Survey of India. This publication has been out of print for many years, and the need of an up to date volume on the geology of the country was long felt not only for the gradually increasing number of students of Indian geology, but also by all those, who required information in regard to the varied geological features and the economic geology of this vast subcontinent.

The volume by Mr Wadia provides an excellent text book, specially suited for students; it has been written by one who has had exceptional opportunities of judging the needs of students as a result of teaching the subject for many years. Further, the work is based on a first hand knowledge of the subject in the field in different parts of India, and also takes full cognizance of the vast published literature on the subject and the extensive unpublished records of the official Geological Survey of India.

The text of the new edition has been thoroughly revised with reference to the results achieved by the Geological Survey of India during a very active quarter of a century or so, and the work of several extra-departmental agencies. Mention may here be made to the brief but excellent account of the structure of the Himalayas with special reference to the *Nappe* Zones, the up to date information on the economic geology of India, and bibliography of the recent literature on the subject. With all these, the bulk of the volume has only increased by 60 pages from that in the 1926 edition.

The work is copiously illustrated. The number of illustrations, some original, others taken from official records, all beautifully reproduced, have invariably been selected with a view to their educative value and usefulness. Special mention in this connection must be made of the geological map of India, on the scale of 95 miles to 1 inch, embodying the results of all recently surveyed regions in the Himalayas, Rajputana, Assam and other parts of India, which forms an appendix to the volume.

The reviewer would like to direct the attention of the author and the publishers to several discrepancies between the headings of various sections, sub-sections, etc., in the contents and in the text,

and the difficulty one experiences in distinguishing between the headings of sections and sub-sections in the contents. It would also have been useful if the page references to all such headings had been included in the very detailed list of contents.

The author deserves the gratitude and thanks of all scientists in India and abroad for providing such a handy volume on the Geology of India. This work, it is hoped, will stimulate the interest of the students and the public in the geology of the country.

B. P.

PRACTICAL CHEMISTRY—*by N. M. Shah. Fourth Edition. (The Student's Own Book Dept. Dharwar). Pp. 95+69 with appendices. Price Rs. 2/4/-.*

This book has been published with a foreward by A. R. Normand M.A., Ph.D., Professor, Wilson College, Bombay. It is claimed that "the book covers the course required for the Intermediate Science Examination in Chemistry of the University of Bombay and it should be suitable for the Intermediate Science Examination of other Indian universities." The book has mainly been divided into two parts. The first part deals with quantitative analysis, gravimetric and volumetric and the preparation and properties of certain gases, evidently for the first year science students. The treatment of salts for qualitative analysis has been discussed in the second part, which is meant for second year students. The last nine pages of the book deal with organic analysis. A few pages of the book have been devoted to "plan of work", meant for teachers. The author has tried his best to devise ideal means of arranging the practical classes. The mode of arrangement of subjects in this book, however, seems to be far from systematic. Such a book serves its purpose best if it gives a clear idea of careful manipulation in chemistry for which the arrangement of apparatus for any particular preparation should be described in detail. Neat and simple diagrams are therefore indispensable. But this has received little consideration from the author. In connection with the preparation of common gases, he has described the preparation of only three; oxygen, carbon dioxide and nitric oxide, and has mentioned the preparation of two other gases, chlorine and sulphur dioxide as exercises. The detailed treatment of determination of equivalent weights seems to be better for a theoretical than for a practical text book. In the second part the basic radicals include arsenic, antimony, bismuth, cobalt, nickel, manganese etc. The necessity of organic analysis in intermediate practical chemistry is not felt by the reviewer. In order to make the book more suitable for I.Sc. students the treatment should have been such that it might help the students in their procedure of work and also in writing their practical note-books.

D. C. S.

INDIAN CENTRAL COTTON COMMITTEE. First Conference of Scientific Research Workers on Cotton in India, March 1937. *Papers read and Summary of Proceedings—Bombay 1938. Pp. 444. Price Indian Rs 4. Foreign 6s. 6d.*

The first conference of its kind was arranged with a view to bring together the scientific workers, both juniors and seniors, of the different Cotton Research Departments functioning under the Indian Central Cotton Committee in various provinces. 'Conferences such as this' remarked the president Sir Bryce Burt 'do much to defeat distance and to mitigate that intellectual isolation which unfortunately is so often the lot of the scientific workers in India'. To solve our different scientific and economic problems the co-operation of both academic and applied workers is needed and the importance of this conference 'is to broaden the outlook of every cotton research worker by bringing him in touch with those working in other branches of science'. From the proceedings published it is hoped that the first conference has initiated the purpose for which it was intended and such conferences would pave the way for further co-operation and mutual understanding of the difficult problems of scientific research for the advancement of cotton cultivation.

The conference met in different sections of entomology, agronomy, technology, mycology, plant breeding and cotton statistics. A good number of papers were read and discussed.

BOOK REVIEW

Papers on insect pests such as the pink boll worm, 'the cotton jassid', 'the cotton stem weevil' and 'spotted boll worm' were read in entomology section. Opinion differed as to the method of carrying over of pink boll worm in North and South India. It is possible that the same pest is carried over through different means, either through seed or through soil in different places. Mr Deshpande laid stress on the importance of his work on spotted boll worms in Gujrat where it is carried over through sprouting plants left in the fields until May and June. Discussing the problem of cotton jassid Mr Afzal Husain concludes that most hairy cottons were resistant to jassids but it is not true that all non-hairy cottons were not resistant and he recommended the egg-laying capacity of the insect on different varieties to be further investigated.

The growth of cotton in relation to different environmental factors were discussed in section of agronomy. The results of water experiments at Risalewalla, Lyallpur obtained by Mr M. Afzal indicated that watering after three weeks throughout the crop season gave the best yield on the average of eight years. Two irrigations in the latter part of the season were not as beneficial as one irrigation early in the season. The importance of the results could be brought out more definitely by further investigation into the soil moisture content and water holding capacity of the soil. The factors brought into play by carrying the experiments in different lands in rotation, have not been accounted for. Amongst the exotic varieties of cotton, the Egyptian cottons do not grow so well as *Desi* or American ones under the soil and climatic conditions of Sind. Leached saline tracks are able to grow *Desi* or Americans better than Egyptians. In discussing the wilting of cotton plants in Sind and Punjab Prof. Dastur gave the interesting analytical results of higher nitrogen content in case of reddened leaves and bad opened plants than the nitrogen content of the plants that had opened well. He had also carried out experiments and found that in those areas where the crop was bad, the soluble nitrates in the soil were not low as was found in Sudan and other places.

The present stage of our knowledge in cotton genetics and cotton breeding was discussed in view of the lines on which genetical work on cotton had been, and would be of value to plant breeding in future. Mr Hutchinson laid stress on the nature of variables, which are expected to be controlled by a large number of genes of small individual effect with cumulative action, and not by single genes as theoretical geneticists are apt to believe. Fisher's idea of variability which is "made up of the contributions of gene differences of small individual magnitude' should be properly appreciated by the application of statistics. This 'law of mass action of genes should be understood and it was only by the application of such laws that genetics could be applied to the plant breeding.'

The changes which have taken place in the cultivated species of cotton and the tendencies of evolution in cotton have been described by Hutchinson in his work on the distribution of Gossypium and the evolution of commercial cottons. 'Skovsted's cytological evidence together with Harland's genetic evidence is considered to give strong support to the theory that 26 chromosome cottons arose by allotetraploidy from a hybrid between 13 chromosome types, one related to the wild 13 chromosome cottons of the New-world and the other related to the cultivated 13 chromosome cottons of Asia; the line of meeting of the two being across the Pacific and not across the Atlantic.'

Several papers on cotton technology and cotton statistics were also read in this conference. Of these the first paper deals with the influence of twist on yarn strength. An equation was developed to determine single thread strength from fibre properties. But in the equation there occurs a factor *viz.*, number of fibres which breaks in a yarn. This number cannot be determined from *a priori* conditions in the present state of knowledge. So if we are to spin a yarn and also to break it by gradual application of load to know the number of fibres which breaks under that tension, we do not need any equation to predict the strength of that yarn at all.

The paper on the deterioration of cotton on storage is quite interesting but the failure of the author to state the details of the cultural and incubating processes adopted by him as well as the particular controls used makes it detract much from its value.

BOOK REVIEW

In the last paper on cotton technology dealing with the effect of rainfall on the quality of Indian cottons the idea seems to be to predict the spinning value of a cotton from the rainfall data. As there are many factors of climate and cultivation as well as of the soil capacity to hold moisture which are independent of rainfall, and at the same time have great effect on spinning quality of cotton, this idea hardly seems plausible.

In cotton statistics there is a very interesting paper on "Sampling Methods in Developmental Studies of Cotton". The subject is important and has been nicely dealt with by author. The discussions on this paper also should draw the attention of all scientific cotton growers.

The different problems of cotton cultivation brought together in this compact book form and discussions given at the end of important papers would give an idea of the type of research work done in India on cotton and it would serve as a good reference to those who are interested in cotton cultivation.

B. K. K.

The Origin of Birds

In any discussion of the origin of birds one comes to the consideration of the nature of the earliest birds, animals with feathers, and, since flight is so characteristic a feature of them, how they came to fly. One favored theory is that certain ancient reptiles, having a habit of running rapidly on their hind legs, learned to flap their arms, at first for balancing. It is supposed that the scales on the front limbs and tail increased in length and breadth, came to be frayed on the edges, grew lighter and eventually were feathers. These scale-feathers furnished the means of flying.

I like much better the idea that feathers, even though they are merely modified scales, were developed at first for warmth, as a protection for lizard-like "reptiles" that lived in the inclement weather of Permian time. The mechanics of the process fits rather well the supposed conditions of the period: (1) a more active lizard pursuing its prey or getting away from danger, (2) rising off the cold ground, (3) running on its hind legs, (4) developing softer and fluffier scales, that (5) furnished some protection from the cold and, (6) in turn contributed to greater activity. Just when warm blood came to be a part of the equipment of the birds no one can state, but it had an immediate advantage when it did come, for it enabled the creature to continue its activities when the other "reptiles" were hibernating.

For a vast period of time such a type of bird would have carried on its existence much as the other animals of its group. But from generation to generation the feathery covering would vary; the feathers would be softer or more bristly, longer or thinner, etc.

*　　*　　*　　*

Now it is entirely within reason that those longer feathers, extending backward from the limbs for wings and from the body to form the tail, increased in stiffness and came to be the very instruments and means of flight. Flying, in our opinion, was not done by a cold, scaly reptile, but by a bird that was already equipped with a warm covering of feathers. It is interesting to note that, while many believe the first birds flew by use of their front limbs and tail, Dr William Beebe conceives of a four-winged origin of flight; he has called this first bird *Tetrapteryx*. Here, too, the stiffened feathers project backward from the limbs and the tail.

—From The Origin of Birds—by Dr Edward L. Troxell in *The Scientific Monthly*.

LETTERS TO THE EDITOR

[The Editor is not responsible for the views expressed in the Letters.]

On the preparation of "Artosterone," a hydroxy ketone related to the male hormone Androsterone, from Artostenone.

It has been shown in previous papers[1] that artostenone the keto-compound which has been isolated from the Indian summer fruit, *Artocarpus integrifolia*, resembles to a great extent all other naturally occurring sterols in constitution.

Ruzicka and his associates[2] have shown that the male hormone androsterone can be prepared in the laboratory from epidihydro cholesterol. It is pleasing to note that adopting the following scheme of procedure it has been possible to prepare a hydroxy ketone which seems to be allied to the male hormone androsterone.

The steps are as follows:— (*a*) Saturation of the double bond by hydrogen in presence of platinum catalyst, (*b*) Conversion of the dihydro artostenone into dihydro artosterol by reduction with sodium and ethyl alcohol, (*c*) Preparation of the acetyl derivative of this alcohol, (*d*) Oxidation of the side chain of the acetyl derivative by means of chromic acid, (*e*) Preparation of the semicarbazone-acetate of the ketone-acetate formed and (*f*) Final hydrolysis of the product to the hydroxy ketone.

The hydroxy ketone androsterone melts at 174.5° whereas this new product has a melting point of 172°—73°.

The name "*Artosterone*" has been proposed for the substance.

Details will shortly be published elsewhere.

My best thanks are due to Prof. J. C. Ghosh for his kind and sympathetic interest in the work and for the facilities offered.

Physiological Laboratory,
Dacca University,
22-3-39.

M. C. Nath.

[1] *Zeit. f. physiol. chem.* 247, 9, 1937; 249, 71, 76, 78, 1937.

[2] *Helv. chim. Acta*, 17, 1395, 1934.

Androgenic Activity of "Artosterone" on the Sexually Immature Male Rats

Influence of *artosterone*, the new hydroxy ketone, which has recently been prepared from artostenone[1] on the sexually immature male rats seems to show that it is highly potent in its activity on the male sex organs.

The prostate and seminal vesicles test developed by Korenchevsky[2] for the assay of androgenic substances has been taken recourse to and it has been observed that the average change in the weight of the prostate and seminal vesicles taken together compared with that of the organs of the control litter mates, even with a very small daily dose (50 γ per day) of artosterone, comes out to be 19% when calculated per 200 g. of the body weight.

It is to be noted that an average increase of 62% of these organs was obtained by Korenchevsky *et al*[3] on growing rats, under almost identical condition, with a daily dose of testicular preparation as high as about 1000γ.

Effects on other organs, such as (*a*) depressing effect on the testes (*b*) acceleration in the rate of retrogression of the thymus and (*c*) stimulating effect on the kidneys etc., which are the characteristic properties of androgenic substances have also been observed.

The result has further been confirmed by histological investigation of the different organs on autopsy. The changes that are noticed in the mucous coat of the *vas deferens* are very interesting. In the control the mucous membrane like the normal is thrown into longitudinal folds almost obliterating the central lumen of the tube, whereas in the experimental one the mucous membrane is stretched up obliterating the longitudinal folds and the central lumen is opened up and much enlarged. Similar effect of androgens on the histological change in the *vas deferense* of capons was observed by Callow and Parkes.[4]

Coming to the structure of the testes, the spermatogenic cells in the seminiferous tubules are less in number and more prominently seen in most of the tubules of the testes of the experimental rats (*i.e.*, rats injected with artosterone in oil) than in the case of the controls where these cells are more closely packed up and found arranged in several layers.

All these observations confirm beyond doubt that artosterone, the newly prepared hydroxy ketone, is highly androgenic.

Further investigations on the effect of this compound on the castrated and ovariectomised rats and on the comb-growth of capones etc., are in progress.

Details about the investigations will shortly be published elsewhere.

Our best thanks are due to Prof. J. C. Ghosh for his kind encouragement in the work and for the facilities offered.

Physiological Laboratory, Dacca University. 22-3-39.

M. C. Nath.
T. N. Sen Gupta.

[1] SCIENCE AND CULTURE, *4*, p. 663, 1939.

[2] *Biochem. Journ.* *26*, 413, 1932.

[3] *Biochem. Journ.* *27*, 557, 1933.

[4] *Biochem. Journ.* *29*, 1415, 1935.

A note on the Crystallographic Investigations of Artostenone by means of the Goniometer and X'ray

Several morphological examinations have been made by means of the Goniometer. The crystal system has been found to be monoclinic. Plane faces *a* (100) of the crystals exhibit pronounced elongation along the *c* axis. Crystallographic studies by means of X-rays give *a*-1.3, *b*-10.2, *c*-7.4 and β-100°49,[1] The molecular weight as calculated from these results comes out to be 424.2 ($C_{30}H_{50}O$ requiring 426 as the molecular weight). The improbability of the presence of the CO group in the position C_3, as in ergosterol, cholesterol etc., has been supported. The results supply additional support to the view that artostenone has got almost the same molecular structure as that of ergosterol.[1]

The authors are thankful to Prof. J. C. Ghosh, Prof. S. N. Bose and Dr K. Banerjee for their kind advice and criticism of this work.

Physiological Section, Chemical Laboratories, and Physical Laboratory, Dacca University. 22-3-39.

M. C. Nath.
P. L. Mukherjee.

[1] Hoppe. Seyler's *Zeit. f. Physiol. chem.* *249*, 71, 76, 78, 1937.

Enantiotropic Transition Between S_α and S_β

In all the existent chemical literatures it is stated that orthorhombic sulphur (S_α) and monoclinic sulphur (S_β) are the two enantiotropic crystalline allotropes of the element. The transition temperature corresponding to the above enantiotropic structural transformation is generally accepted to be 96°.5C. S_α is the stable modification below the transition point whereas S_β is stable above it up to its melting point. Thus monoclinic sulphur, prepared by the usual method of solidification of molten sulphur heated to a temperature of about 130°C, gradually passes into the stable α-phase when it is kept below 96.°5C. Similarly it is held that orthorhombic sulphur also passes into the β-phase above 96.°5C.

During the investigation on the allotropes of sulphur by the X-ray diffraction method,[1] the present author has noticed that S_β prepared from molten sulphur is really very unstable at the ordinary room temperature and quickly undergoes the structural transformation into the α-phase. Moreover the transformation is almost instantaneous when the specimen of S_β is mechanically disturbed as during the process of powdering in a mortar. Photographs with such a powder at the room temperature show a pure S_α-pattern, even when the diffracting specimen is replaced at intervals of half an hour by freshly prepared ones. The author's other observations also agree with those of the previous works so far as the transformation of S_β to S_α is effected though the author has not been able to determine the critical temperature for such a transition.

On the contrary, results of careful investigations on the transition of S_α into S_β between 96.°5C and the melting point of the element have failed to detect any such transformation (S_α to S_β).

One method of attacking this problem was by studying the Laue-Spots by single S_α crystals. In this case, one face was made approximately perpendicular to the incident X-ray. The single crystal was heated and it was found that up to 97°C, regular spots could be noticed but after that temperature the crystal invariably broke and nothing definite could be said about such transformation (S_α to S_β) temperature.

In the second method a cell of sulphur was prepared and it was heated up to 96.°5C. The diffraction photographs only exhibited streaks and dots showing only the growth of sulphur crystals. In order to avoid this growth, a very thin celluloid film containing finely powdered sulphur was prepared. This method had the advantage of preventing the growth of crystals in the powdered mass. Photographs of this specimen (sulphur-in-celluloid-film) was kept for about 80 hours at 104°C. The X-ray diffraction photographs only exhibited rings of pure S_α pattern. It may be mentioned here that no trace of dots or streaks appeared on the photographic plate. The cell was further heated to about 114°C and even at this temperature no trace of S_β ring could be detected.

From these experiments it may be concluded that S_α is not converted into S_β at any temperature below the melting

point, and that $S\beta$ can only be prepared from molten sulphur.

Physies Laboratory, S. R. Das.
University College of Science,
92, Upper Circular Road,
Calcutta, 17-3-39.

[1] Das, *Ind. Jour. Phys.* Vol. XII, Part III, 1938.

Partially Balanced Incomplete Block Designs

There exists a general type of design which includes as special cases, both the two dimensional quasifactorial designs with constant block size and the balanced incomplete block designs of Yates,[1] which are useful for large scale varietal trials.

If there are v varieties, each replicated r times, in blocks with k plots each, then for the existence of our design the following conditions should hold:—

(i) With respect to each variety, the remaining $(v-1)$ varieties, fall into two groups of n_1 and n_2 varieties such that the members of i th group occur with that variety in λ_i blocks (i=1, 2).

(ii) We can suppose without loss of generality: $\lambda_1 > \lambda_2$. Two varieties occurring together λ_i times may be called i—associates (i=1, 2). If any two varieties are i—associates, then the number of varieties common to the j—associates, of one of these, and the k—associates of the other is denoted by p^i_{jk} and is independent of which pair of i- associates we start with. Clearly $p^i_{jk} = p^i_{kj}$ (i, j, k=1, 2).

The parameters involved in the design satisfy the following relations, only six of them being indepeadent:

$$\left.\begin{array}{c} bk = vr,\ v = 1 + n_1 + n_2 \\ r(k-1) = n_1\lambda_1 + n_2\lambda_2 \\ p^1_{11} + p^1_{12} = n_1 - 1, \quad p^2_{11} + p^2_{12} = n_1 \\ p^1_{21} + p^1_{22} = n_2, \quad p^2_{22} + p^2_{21} = n_2 - 1 \\ n_1 p^1_{12} = n_2 p^2_{11},\ n_1 p^1_{22} = n_2 p^2_{12} \end{array}\right\} \quad (1)$$

Three examples may be given here not included in any of the designs given by Yates: (a) The 9 points and 9 lines of a Pappus configuration may be taken as the varieties and blocks of a design, (b) The 10 points and 10 lines of a Des-argue configuration may be treated similarly. (c) Starting from the initial block 1, 2, 8, 17, 21, 24, 25, 26 we may get 28 other blocks by the addition of the numbers 1 to 28 and taking residues (mod. 29).

Let Q_i denote, k times the total of all plots in which the i th variety occurs, *minus* the sum of the totals of r blocks in which that variety is replicated. If v_i denotes the estimate of the effect of the i-th variety, then on the supposition, $n_1 > n_2$,

$$v_i = \frac{[r(k-1) + \lambda_1 + (\lambda_1 - \lambda_2)(p^2_{22} - p^1_{22})] \times Q_i + (\lambda_1 - \lambda_2)\Sigma Q(\lambda_2)}{\{r(k-1) + \lambda_1\}[r(k-1) + \lambda_1 + (\lambda_1 - \lambda_2)(p^2_{22} - p^1_{22})] - (\lambda_1 - \lambda_2)^2 p^1_{12}}, \quad (2)$$

where $\Sigma Q(\lambda_2)$ comprises the Q's corresponding to the n_2 varieties which are 2nd associates of the i th variety, a similar expression being obtainable when $n_1 < n_2$.

The sum of squares due to varieties in the analysis of variance is

$$\Sigma v_i Q_i / k \quad (3)$$

In terms of the variance per plot, the variance of the difference between the estimated effects of two varieties which are first associates is

$$2k[r(k-1) + \lambda_1 + (\lambda_1 - \lambda_2)(p^2_{22} - p^1_{22})] / D \quad (4)$$

where D is the denominator of the right hand side in (2), and a similar result holds when the varieties are second associates.

The efficiency of our design is given by

$$\frac{(v-1)D}{rk[vr(k-1) + (\lambda_1 - \lambda_2)\{n_1(p^2_{22} - p^1_{22}) + n_2(p^1_{11} - p^2_{11})\}]} \quad (5)$$

which reduces to $\dfrac{1 - 1/k}{1 - 1/v}$ when $\lambda_1 = \lambda_2$.

The efficiency factors of the three designs cited as examples are 8,11. 40, 57. 3335, 3712.

Instead of two λ's as considered above, we might have considered m, λ's so that there are m kinds of associates. Full details will be given in a forthcoming paper in *Sankhya*, the Indian Journal of Statistics.

Statistical Laboratory, R. C. Bose,
Presidency College, K. R. Nair.
Calcutta, 22-3-39.

[1] F. Yates: *The Design and Analysis of Factorial Experiments* (1937) Technical Communication No. 35, Imperial Bureau of Soil Science.

Vitamin C in *Shim*

That the vitamin C content of several food stuffs increases when they are boiled or warmed with water is now admitted on all hands. This phenomenon has recently been noticed in the case of *Shims*. But here the increase appears mostly to be due to the softening of the pulps of the beans on heating with water. The vitamin C values in this present instance have been determined by the method of Harris and Ray[1] as modified by Guha and Ghosh[2] and Ghosh and Guha[3].

Several varieties of the stuff were taken and freed from the non-edible portion, if any. 10 gms. of each of the substances were weighed out into a mortar with 2·5 c.c. of 20% trichloroacetic acid and a few gms. of Merck's sea sand. They were then finely ground with the addition of a few c.c. of distilled water and centrifuged. The centrifugate was made up to 100 c.c. and titrated against 2·6 dichlorophenol indophenol according to the method of Guha and Ghosh as mentioned above. In the case of pigmented extracts—the

method of Tillmans[4] *et al* as modified by McHenry and Graham[5] was adopted. Three sets of experiments were made from the stuffs procured from the market on different days, so as to obtain a good average. The results obtained are given in Table I. Another lot of 10 gms of each of the varieties were taken in a basin and boiled in each case with 150 c.c. of water for 15 minutes, the water added being mostly evaporated by that time. They were then taken in a mortar with 2·5 c.c. 20% trichloroacetic acid solution and a few gms of Merck's sea sand and treated in the aforesaid way. The results obtained are given in Table II

TABLE I.

Ascorbic acid in mg. per 100 gms. of Shim (Dolichos lablab)

	Green, thin.	Green, flat.	White, thin.	White, flat.	White Red border thin.	White Red border flat.	Green Violet border
	0.96	0.93	0.71	0.63	1.00	0.83	0.83
	1.04	0.83	0.89	0.83	0.63	0.71	1.39
	1.04	0.83	1.25	1.25	0.83	0.78	1.14
Average	1.01	0.86	0.95	0.90	0.82	0.77	1.12

TABLE II.

Ascorbic acid in mg. per 100 gms. (after boiling the stuff with 150 c.c. of water for 15 minutes).

	Green, thin.	Green, flat.	White, thin.	White, flat.	White Red border thin.	White Red border flat.	Green Violet border
	9.09	9.26	7.81	5.95	10.00	7.81	8.93
	9.80	6.94	10.87	6.25	7.81	5.56	10.56
	11.90	8.93	9.25	8.33	7.81	8.62	9.27
Average	10.26	8.38	9.31	8.84	8.54	7.33	9.69

From a comparison of the Tables it is found that the vitamin C content of the boiled *shim* is in almost every case 10 times that obtained from the raw ones estimated in the same way.

Our sincere thanks are due to the authorities of the firm.

Bengal Chemical & Pharmaceutical Works, Ltd. Calcutta, 8-3-39.

H. G. Biswas.
K. L. Das.

[1] Harris and Roy, *Biochem. J.*, *27*, 303, 1933.

[2] Ghosh and Guha, *J. Indian Chem. Soc.*, *12*, 30, 1935.

[3] Guha and Ghosh, *Current Science*, *2*, 390, 1935.

[4] Tillmans *et al*, *Z. Untersuch. Lebens.*, *63*, 241, 1932.

[5] McHenry E. W. and Graham M, *Biochem. J.*, *29*, 2013, 1935.

On Completely Orthogonalised Sets of Latin Squares

A set of any n letters $A\ B\ C\ D\ldots\ldots$ or n numbers $0\ 1\ 2\ \ldots\ldots\ (n-1)$ when arranged in a $n \times n$ square in such a way that every letter or number occurs just once in every row and every column, may be said to form a Latin Square.[1] The Latin Square is said to be in the standard form ~~if the~~ letters or numbers of the first row and the first column are in the standard order $A\ B\ C\ D\ldots$ or $0\ 1\ 2\ldots\ (n-1)$. Two Latin Squares are said to be orthogonal, when if they are superimposed, any letter of the first square occurs just once with every letter of the other square. $(n-1)$ mutually orthogonal $n \times n$ Latin Squares form a complete set, and the set will be said to be in the standard form, if the first square is in the standard form, and the letters in the top lines of the other squares are in their natural order.

Complete sets of orthogonalised Latin Squares were known to exist for the cases $n = 2, 3, 4, 5, 7, 8$ and 9. One of the authors (R. C. Bose) first showed, by using the properties of Galois fields, that such a set can be constructed when n is any prime or a power of a prime.[2] The same result was later obtained independently by Stevens.[3] Every orthogonalised set has associated to it a finite geometry, which is Desarguesian when and only when the set is derivable from a Galois field. It can be shown that all completely orthogonalised sets for $n \leq 5$ must be derivable from a Galois field, but for larger values of n there may be both Desarguesian (Galois) and Non-Desarguesian sets. Every Desarguesian set in the standard form can be constructed by means of the formula

$$\alpha_j = \alpha_i \alpha_p + \alpha_q$$

by identifying the symbols $\alpha_0, \alpha_1, \alpha_2, \ldots\ldots \alpha_n$, $(n = p^m)$ with the p^m elements of a Galois field in any order, except that α_0 is always the null element and α_1 the unit element of the field, and then putting number j in the cell (p, q) of the i th square. This helps us to decide whether a given set is of the Desarguesian (Galois) type, and we have evolved a technique by which the proper identification for a given square can be readily discovered. It is also seen that the number of standard sets belonging to the Galois type is

$$(p^m - 2)!\,/\,m$$

since $x \rightarrow x^p$ is an isomorphism of the Galois field $GF\,[p^m]$.

Stevens has already noted that the 9×9 set given by Fisher[4] is of the Galois type, and it is easy to show that the same applies to the 8×8 set given there. Their identifications are readily obtainable and will be given in our paper. That the 9×9 set of squares due to Yates[4] is not of the Galois type has also been noted by Stevens. It is of great interest to determine the exact nature of Yates's set.

There exist more general types of algebras than the algebra of Galois fields, called algebras $A\,[p^m]$ by Carmichael.[5] Yates's set of squares can be derived by the help of a certain algebra $A\,[3^2]$ constructed as follows. Let α_i be the elements of $G\,F\,[3^2]$ given by

$$\alpha_0 = 0, \qquad \alpha_1 = 1, \qquad \alpha_2 = 2 = x^4$$
$$\alpha_3 = x + 2 = x^6, \quad \alpha_4 = x, \qquad \alpha_5 = x + 1 = x^7$$
$$\alpha_6 = 2\,x + 1 = x^2, \quad \alpha_7 = 2\,x + 2 = x^3, \quad \alpha_8 = 2\,x = x^5.$$

They can be added by taking them in the form $a\,x + b$,

adding as usual and reducing (mod. 3). They can be multiplied by taking them in the form x^r multiplying as usual and reducing by using the relation $x^8 = 1$. We now take a new set of nine elements β_i and let $\beta_i + \beta_j = \beta_k$ if $\alpha_i + \alpha_j = \alpha_k$. If α_i is a square, *i.e.* of the form x^{2s}, let $\beta_i \beta_j = \beta_k$ if $\alpha_i \alpha_j = \alpha_k$, but if α_i is non-square, *i.e.* of the form x^{2s+1} let $\beta_i \beta_j = \beta_k$ when $\alpha_i \alpha_j^3 = \alpha_k$.

Then Yates's square comes by using the formula

$$\beta_j = \beta_i \beta_p + \beta_q$$

and by putting the number j in the cell (p, q) of the i th square.

Any given completely orthogonalised set of Latin Squares can be brought in the standard form by just applying to all the squares of the set, row and column interchanges bringing one square to the standard form, and by permutations of the letters within each of the remaining squares, so as to bring the top row in the standard order. When thus standarised all the hitherto known sets of squares (as noticed by Stevens) are such that all squares of a given set are derivable from any one square by suitable row permutations only.

From the Non-Desarguesian Geometry of Veblen, (Carmichael, p. 411) with 91 points we have now constructed a completely orthogonalised set in the standard form, in which the different squares of the set do not differ merely by a permutation of the rows. We believe that it is the first example of this kind to be discovered. Fuller details will appear in a subsequent paper in the *Sankhya*.

Statistical Laboratory, Calcutta, 12-4-39.

K. R. Nair.
R. C. Bose.

[1] Fisher, R. A. and Yates, F.: *Statistical Tables*, (Oliver and Boyd), 1938.

[2] Bose, R. C.: *Sankhya*, Vol. 3, Part 4 pp. 323-338, November 1938.

[3] Stevens, W. L.: *The Annals of Eugenics*, Vol. IX, Part 1, pp. 82-93, January 1939.

[4] Fisher, R. A.: *The Design of Experiments*, (Second Edition, Oliver and Boyd), 1937.

[5] Carmichael, R. D.: *Introduction to the Theory of Groups of Finite Order*, (Ginn & Co.), 1937.

SCIENCE AND CULTURE

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National Planning in Sweden

Sir James Grigg who has just laid down the high office of the Finance Minister to the Government of India had no faith in planned economy, a view which found ready support in bureaucratic circles in this country. As custodian of India's financial interests, he rarely departed from the traditional British principles of free competition in the production and distribution of goods; and the only advice which he could give to the Indian people during the extraordinary phases of the depression of 1931 was to tighten their belts and bring out their distress gold. Even the normal capital expenditure on railways and other civil works was considerably cut down; and at the end of his period of office he had the satisfaction that the credit of the Government of India had never stood higher before.

After a consideration of this orthodox but barren policy, which has resulted in a grave deterioration of the already low standard of living in India, it is a relief to turn to the pictures where Governments are making great experiments to alleviate the distress of their nationals. The question of depression or boom does not arise in countries like Soviet Russia, where all the major factors of production have been nationalised and lands, mines, factories, railroads and banks and even foreign trade have been made State monopolies. But today even in capitalistic countries outside Russia, *e.g.*, the U. S. A., Italy, and Germany, and even Britain not excepted, a large degree of State control over the factors of production is being enforced so as to radically alter the substance of private property even though the form of it may have been left intact.

The New Fabian Research Bureau has recently carried out direct investigations on the spot of the political, economic and industrial systems of Sweden and has presented a report,* which will be of extreme interest to all who believe that economic planning might be reconciled with a large degree of freedom of initiation and enterprise and we make no apology in presenting to our readers some aspects of this fascinating survey.

* *Democratic Sweden*—Published by the New Fabian Research Bureau.

NATIONAL PLANNING IN SWEDEN

Economic Policy—Back to Joseph

With the advent of the Social Democrats in power in Sweden, the principle underlying the Government's financial policy has been completely changed. The aim of the annual budget now is not merely to balance current revenue against current expenditure from year to year, but to think ahead for a number of years and to adopt a policy which will exercise a stabilising influence upon the whole economic life of the country. When trade is bad, private profit-making concerns become shy of fresh capital investment, but according to the new theory the Government should not allow itself to be affected by similar considerations. The policy of the Government should be such as to stimulate economic recovery and provide work for the unemployed. Hence a public works policy has been adopted which implies the deliberate postponement of public development during boom years in order that work on a more extensive scale may be undertaken during time of depression when private enterprise is contracting and when money and materials are cheap. This policy is reflected in the budgetary provision for public works which increased from 23 million kroners* in 1929-30 to 246 million kroners in 1933-34. This excess expenditure was met by large scale borrowing during periods of depression. According to the new theory, lean years and fat years come in alternate succession, and if the budget is to be used effectively as an instrument of economic policy it is impossible and unwise to try to balance it for each year, good or bad. In bad years there will be an excess of expenditure over revenue and the deficit must be met by loans. During good years, revenue will exceed expenditure and the surplus will be used to repay the loans incurred during the lean years. Provided the budget balances over a period of years between the peaks of the trade cycle, it is relatively unimportant whether or not it balances for any given year. The theory is that loan should be raised during the downward trend of the trade cycle in order to finance an expansionist policy and should be repaid out of income during the upward trend of the cycle, and Swedish experience tends to show that there are no insuperable difficulties in adopting a policy of this kind. The Swedish Government appears to have followed the policy of the wise Hebrew Patriarch Joseph who, as Wazir to the Pharaoh, practised the same policy with conspicuous results four thousand years ago. That such a policy will stabilise wage levels, will check unemployment and will also accelerate a trade revival seems to be fairly certain. The 800 million kroners spent in public works in Sweden between 1933 and 1938 have helped to maintain a standard of living which is the envy of many countries in Europe. The financial collapse predicted by orthodox bankers is yet far off, as the interest and sinking fund for these loans have been amply provided for from increased taxation on alcoholic drinks. The success of Swedish measures should be an object lesson to the Government of India whose financial policy is controlled by the Bank of England for the interest of British plutocracy, and also to the provincial Governments who are at present so keen on moral uplift of the masses by prohibition.

* 1·47 kroner is equal in value to one rupee.

Power Development in Sweden

Before the Great War, Sweden depended for her power supply on coal imported from England and Germany. The development of her great hydroelectric resources was just beginning. But during the War, the foreign coal supply was greatly reduced; and her industries and systems of transport suffered enormously on account of coal shortage. This was a lesson which Sweden did not forget. In post War years, she devoted all her energy to the development of her power resources. What is the result now? Today in Sweden, the production of electricity *per capita* is 1,200 k.W.h. all derived from water power, for Sweden has practically no coal. Fifty per cent of this enormous power is directly produced by State and municipal undertakings but the policy, the management and the development of the entire electric supply system are controlled by the Royal Board of Waterfalls. The symposium on problems of power supply held sometime ago under the auspices of the National Academy of Sciences, India, creates the impression that hydroelectric projects under State ownership in India are costly undertakings which are not capable of selling power cheap, but it has not yet

been proved whether the failure of hydroelectric schemes in India under State initiative is due to mismanagement or some innate defect in the situation of the power resources. The Swedish experience is altogether different. There the price varies from ·3*d.* per unit for a demand of 4,000 k.W. to ·56*d.* for a demand of 200 k.W. which is lower than the British Grid charges. Even with such low prices, it has been possible to secure a net return of 6·1% per year on the total capital investment including the estimated value of water power sites.

The extensive generating and transmission systems owned by the Board of Waterfalls already covers most of Sweden, and will in the course of another year or two form a complete industrial backbone of the country stretching from the extreme south to the extreme north. The projected development of the northern water power resources of Sweden is of twofold importance. In the first place, it means the harnessing of very extensive power sources which as yet have hardly been touched. In the second place, northern water power reaches its maximum in the summer when snow melts, whereas southern water power is at its maximum in the winter when rainfall is the heaviest.

Sweden has a population of only 6·1 millions living in an area of 173,000 sq. miles. The rural areas are very sparsely populated, but even then, it has been possible to supply cheap electricity to 60% of the farms. The system which has been responsible for such remarkable development in rural areas is described as follows.

Rural Electricity Supply

A co-operative association is formed by a number of farmers in a rural district coming together and either subscribing the capital required to construct a low voltage distribution net work or guaranteeing the interest and sinking fund on loans raised from special State funds. This association then enters into an agreement with the Board of Waterfalls for a bulk supply at 3,000 volts. With the guidance of the Board, the association constructs the overhead lines, purchases transformers, switchgears etc., and provides the connection to each consumer's premises. It also employs generally one trained linesman whose job is to maintain the overhead lines and read the meters. He also does, in addition, wiring work for the consumer and maintains his equipment. The consumer-owner also takes a keen interest in the problem of electric supply and himself acquires a good deal of technical knowledge. It is therefore possible to do things at a cost, whose cheapness appears to be incredible in other countries.

Nearly 4,000 kilometers of Swedish railways out of a total of 16,000 are electrified. This includes about half of the total route mileage of the State railway carrying 80% of the traffic; and during recent years, electrification has been proceeding at the rate of one kilometer of route per day. In spite of a highly developed private motor bus service, the railway administration has always paid to the Treasury the full interest and renewal fund contributions on the total capital investment, and this has been done without neglecting the comforts of the passengers. As a matter of fact, the cleanliness and comfort of Swedish electrified railways may well make British passengers wish that the British railways had all been electrified.

Swedish Agriculture

It is interesting to examine in detail the weekly consumption of various kinds of food of a family of 3·3 consuming units.

	Meat in lb.	Fish. lb.	Butter. lb.	Margarine lb.	Eggs No.	Bread. lb.	Potatoes, lb.	Sugar. lb.	Milk pints.
Workman in city	8·4	2·9	1·5	1·6	18	12	14	6·3	25·6
Agricultural worker	4	·7	1·15	1·29	9	19	22	5	41

The magnificent physique of the Swedish people is common knowledge. They are on the average at least two inches taller and correspondingly broader

than the English people. Their natural surroundings, their food, and the famous Swedish drill are all conducive to this. About 40% of the people are directly engaged on agricultural production, about 12% of the soil is directly utilised for food crops, and about 80% of the farms are owner-occupied. It has been always the policy of the State to supply capital at very low rates to farmers for improvement of the farms. Draining, an extremely important problem under Swedish conditions, has received great encouragement, and annually some 70,000 acres are drained by free grants from the State. Farming skill in Sweden is very high, and the agriculture system and farm economy must remain the admiration and envy of those qualified to assess its qualities. "One of the most startling and rapid changes introduced in the last few years has been the expansion of wheat growing areas at the expense of the rye crops. Rye as a bread crop had long held a preeminent position in Sweden, but with the changing standards of living, the demand for wheat increased greatly. Response to this demand has been remarkably quick and within the last ten years, the average harvest in wheat is of sufficient quality and quantity to supply the home demand. It has been a great triumph not only for the farmer but also the plant breeder who rose to the occasion and produced after research the necessary strains and varieties for Swedish conditions. The very closest contact has always existed between the scientist and the farmer, the one having been prepared to apply much of his time to the practical field, the other ready to adopt and to use the materials made available. Today Sweden leads the world in the science of plant breeding, and upon her, even England relies for much of her farm seed."

The country is also self-supporting in meat, sugar and potatoes (the excess manufactured as alcohol).

Animal production has increased very considerably, and a large part of the cropped land is used for cattle food, for conversion to milk, butter and meat. Indeed the agricultural worker in Sweden drinks milk in quantities which would even satisfy the exacting requirements of the Health Section of the League of Nations.

The following table gives a sort of bird's eye view of the industrial and economic structure of the country.

Industrial Units.	Value of Output in 1935 in Million Kroner.
Iron Ore Mining	104
Iron and Steel Production	250
Iron and Steel Manufacture, Machinery and Ship Building	1,106
Other Metal Goods	200
Quarrying, Brick and Glass	179
Saw Milling	251
Wood Manufacture	144
Wood Pulp and Paper	485
Printing, etc.	214
Food and Drink	1,251
Textiles and Clothing	503
Leather and Rubber Goods	203
Chemicals, Matches, etc.	264
Water, Gas and Electricity	222
TOTAL	5,476

The annual value of industrial and agricultural output per capita thus stands at 900 kroners approximately. First and foremost, there are the primary undertakings, iron-mining, lumbering and quarrying. In these sections technical progress has been very rapid. Secondly, there has been a tremendous advance in the production of a long range of semi manufactured products derived directly from natural sources, steel plates, ferro-alloy, wood pulp, plywood, metal ware and so on. Thirdly, there are a number of highly specialised engineering undertakings, based for the most part upon Swedish inventions and technical skill. Companies such as Swedish Ball Bearing Co., which supply some three quarters of the ball bearings used outside the United States, the Ericsson Telephone Co., the A. B. Separator, the Aga Group, the Asea Electrical Equipment firm, the De Laval Steam Turbine Company are concerns of international significance based upon Swedish technical discovery.

A Country of Small Capitalists

This highly diversified industrial structure is distributed almost equally diversely over the country. Here again we see the result of lack of

coal. In Sweden there has been a concentration of population to industrial areas suitably located for the exploitation of her natural resources. Thus in Lapland, we have an isolated community which has grown up round the rich iron-fields. The ore-fields in central Sweden have naturally become the centre of the steel industry, conveniently placed too for the supply of charcoal for smelting; the saw-milling, and the wood pulp and paper industries are necessarily concentrated at the river mouths on the east coast. There is also a general industrial concentration around the three big ports of Stockholm, Göteborg and Malmo. The specialised exporting engineering industry have developed there. The geographical distribution of industry is most important in the avoidance of the grimmer consequences of industrialisation. And from the point of view of town planning and from the general social and political point of view, the advantages are immense. Swedish industry is still relatively small scale; only 23·6 per cent of industrial workers being engaged in plants and factories which employ more than 500 men; and the tendency for the rapid increase of small units shows that there is very much more scope for the enterprising "small" man in Sweden than there is in the more developed and monopolistic countries like England or the U. S. A. These facts have considerable relevance to the comperative freedom from major social conflicts which Sweden enjoys. In any case, the fact remains, that Sweden is not a *class ridden* State in anything like the way that Great Britain is, nor does there exist that vast difference in income levels, which we find in the so called democracies of western Europe and America. Sweden lacks both the English extremes —the black helpless poverty of the depressed areas and the staggering superfluity which is flaunted in London shops, and coldly exposed in the return of death duties.

Sweden is also lucky in escaping domination of extreme political doctrines communism and fascism of the dictators or the imperialism of the Kipling brand. For better and worse, she has definitely put her past behind, and her people are far less dominated by their own national history than other countries. They are not perpetually mourning their lost glories, *e.g.*, dazzling victories of Charles XII over surrounding countries followed by depressing reverses, or spinning fantastic dreams of future greatness. The result has been the evolution of a civilised community which has reaped the fruits of modern scientific progress but has kept down the evils of industrialism and militarism in its social life, and organisation. Sweden is a country of very small population in comparison with its area. It has an easy climate and enough natural resources to build up a decent standard of living. But mere possession of natural resources is not enough. "The people should have the genius to appreciate the necessity for the development and exploration of these resources"; this the Swedish people have done in an eminent degree. The patriots of India who view with suspicion everything that comes from the West should do well to study the amazing progress which has been made by this homogeneous people who have steered clear of the many evils which in India are now so frequently associated with scientific industrialisation, and who, by their amazing success in planned economy, under genuine democratic conditions, have demonstrated the hollowness of the claims of the '*Laissez Faire*' policy of the central bureaucracy, and the unsoundness of the 'Back to *Vedas*' policy of the orthodox Congress in this country.

Vernalization in the Tropics

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The discovery of the process of vernalization has been one of the most remarkable achievements in Russian agriculture. The extension of cultivation to the arctic regions where it has hitherto been a hazardous task, the cultivation of spring wheats in the semi-arid zones of Ukrainian steppes where the high temperature damaged the crop just prior to heading, the possibilities of growing more than one generation of plants within the same year and the general improvement in yield with regard to both quantity and quality are amongst others a few of its accomplishments.

Whereas the results obtained on the utility of vernalization in the temperate belt have been very striking and beneficial, our knowledge with regard to its effectiveness in the tropics is yet meagre. A summary of the work conducted in these regions, little as it is, has already been published in previous issues of this journal (Jan. 37, July 37 and Feb. 39) and in I. A. B. bulletins (Nos. 9 and 17) and needs no further repetition. These contributions have rendered good service to workers along this line in two ways, *viz.*,

(*i*) They have popularised the understanding of the process, and

(*ii*) They have revealed the actual position of tropical workers in this field.

In fact, the discovery of the process of vernalization dates back to 1857, though it came to be widely known only after Lysenko's extensive investigations in 1928 in Russia. Work in this sphere was subsequently started at the Institute of Agricultural Research, Benares, but despite the long period of years covered in this direction, it has not been possible to put forth earlier conclusions. This has obviously been due to the manifold difficulties that needed solution and also to the fact that repeated confirmation of the results was required. While discussing, the possible prospects of the process in these regions it would, however, not be out of place to mention some of its salient limitations because of which its working has more frequently met with re rather than success.

Climatic limitation

Climatic diversity has been one of the chief limitations towards the success of the scheme of vernalization in these regions. Despite the marked contrast between the temperate and the tropical climates, the investigators, more specially in this country, have been working along the lines scheduled by foreign workers. The climatic diversity coupled with the absence of a very definite knowledge of the behaviour of plants to differential environment, added by ignorance of the precise developmental phases of the tropical plants, have, therefore, led the workers to conflicting and inconclusive evidence as exists to-day. This necessitates taking recourse to an absolutely independent enquiry before the scheme of vernalization can be expected to yield any successful results.

Choice of dose

The choice of vernalization dose, which is likely to differ for different plant species and even for different strains of the same species, has more often been arbitrary basing upon the investigations of foreign workers. Such experimentation, therefore, has usually met with failure instead of success. The vernalized and the unvernalized seeds though structurally indistinguishable and

agronomically still seeds, is nonetheless strongly contrasted metabolically and as such is easily amenable to physiological diagnosis. Since respiration has been found as the most important indicator of protoplasmic activity, and enzymes that of vitality and vigour of the organism, so much so that to some (Heinicke, A. J., Cornell Univ. *Agr. Sta. Mem. 62*, 1923) they are more sensitive measures of the metabolic status of a tissue than even the usual chemical methods, attention may, therefore, be directed to some such quantitative physiological characteristics in diagnosing correct vernalization and in predicting a suitable dose within a reasonable range of temperature and a suitable period of chilling before this process is recommended on agricultural scale to yield maximum effects. A study in this regard revealed that a higher rate of respiration and enzymic activity is almost always associated with the prospective dose.

Basis of classification

Even the system of classification of plants into (*i*) long-day—where flowering is indicated to be favoured by relatively long days or even continuous illumination, (*ii*) short day- where relatively short days are the essential preliminary to induce the same, and (*iii*) day neutrals -where day length bears obviously little effect on sexual reproduction, adopted by workers like Klebs and Garner and Allard seems to be entirely empirical; and whether it is at all applicable to the tropics is a problem all important in itself. Most of the crops, *e.g.*, millets, maize, sorghum etc., grouped by these workers as short day, are almost invariably cultivated in this country in the longest days of the year and which still flourish to their maximum. Some of them when grown, on the contrary, in short days are found to be associated with poor yield and with several anomalies, for which the theory of photoperiodism fails to provide an adequate explanation. Maize may be cited as a concrete example in this direction wherein among other abnormalities the normal staminate tassels completely trensformed into pistillate cobs when grown at our Institute experiment station late in short winter days as also under controlled deficient photo periods (Fig. 1).

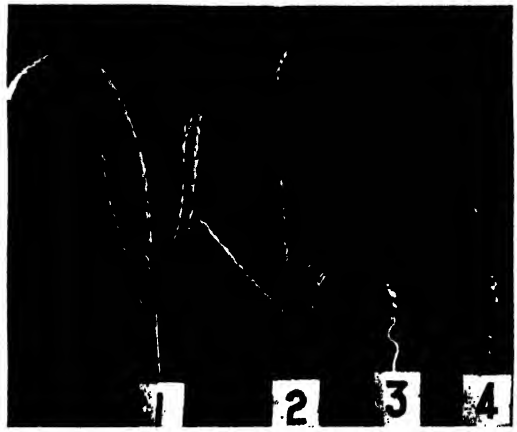

Fig. 1

Various transitional forms of *Zea mays* tassel (from a profusely branched panicle to a pistillate cob) obtained from a pot-culture crop grown 'in season' under normal and controlled deficient photoperiods. (1) Control—14 hrs., (2) 12 hrs., (3) 9 hrs., and (4) 6 hrs.

Refrigeration

Refrigeration for lowering the temperature of seeds and seedlings in the tropics is both difficult and expensive, more specially for the large-size seeds and as such has been one of the main handicaps in the way of the tropical investigators. Though a cheap refrigeration to this effect may as well be possible in the near future but under the present state of affairs a more economic way of usefully applying vernalization in this region is either in the use of the thermophilic types like cotton where the temperature is comparatively easy of maintenance or through the use of exceedingly small seeds, *e.g.*, those of tobacco which occupy a little space (300,000 to an oz.) even when in large numbers.

Choice of crop

Long durationed crops covering more than the limits of a single season, grown exclusively for either the seeds or for the foliage are more difficult to be advantageously affected after vernalization than crops with shorter life cycle and capable of being used both for food and fodder. Cosmopolitan crops

like tobacco having an unusually wide range of climatic tolerance with the additional advantage of having slow germinating power are best suited for vernalization in these regions. The accompanying photograph (Fig. 2) well indicates some of the variations found in a poteulture crop grown after seed vernalization at our experiment station. The flowering time characteristically differed in the two cases, so that (as seen in the photograph) when blossoms in the unvernalized lot were in bud state, in the vernalized they were far mature and completed fertilization.

Fig. 2

Showing characteristic variations in tobacco plants following seed vernalization. C—Control and T—Treated (vernalized).

Thus, notable differences could be easily recorded in the initiation and development of floral primordia, in the number and size of leaves, in the height of plants and in nicotine percentage. To more clearly express these variations, relevant data have been produced in Table I.

TABLE I

Variations Following Seed Vernalization in Tobacco

Period of soaking in water = 24 hrs.

Temperature during vern. = 5° c.

Item.	Control.	Vernalized.
Date of treatment ..	....	Nov. 15th
Date of sowing ..	Dec. 1st	Dec. 1st
Date of blossoming ..	March 14th	March 1st
Date of harvesting ..	April 16th	April 8th
Av. no. of capsules per plant	19±0·279	40±0·549
Av. size of leaf in sq. cms.	529±2·175	581±1·760
Av. height per plant in cms.	106·2+0·859	158·3±1·280
Nicotine percentage ..	1·895	3·369

After-effects of vernalization

In visualizing vernalization effects conclusions have often been drawn by workers in this country upon comparative germination figures of treated and untreated seeds, which in fact is not the standard criterion of diagnosing treatment value. For, cases are not uncommon where the final yield is higher even though the germination of seeds is actually retarded by such treatments.

Experimentation has further shown that changes produced in the cells of the embryo during vernalization constitute some permanent changes of state which are passed on to the later stages of the organism, so that it can well resist the fluctuations of the everchanging environment. Some of the American cottons that failed to flourish in these regions gradually bridged, on repeated vernalization, the environic gulf that exists between their indigenous and new surroundings. Vernalization, for instance, of Punjab American cotton (a thermophilic type) at our experiment station for 3-4 successive generations increased both the production

and maturation of bolls much beyond the normal so that the ginning outturn increased by more than 3 times its usual weight. (Table II).

TABLE II

*Variations in Punjab American Cotton (var. 289 F) Following 3 Years' Repeated Vernalization**

Period of soaking in water—36 hrs.

Temperature during vern. —23±1·2° c.

Item.	Control.	Vernalized.
Date of treatment ..	....	June 20th
Date of sowing ..	July 3rd	July 3rd
Date of blossoming ..	Oct. 2nd	Sept. 22nd
Date of harvesting ..	Dec. 5th	Nov. 11th
Av. no. of bolls per plant	15·3±0·290	27·6±0·415
Av. no. of open bolls per plant	5·1±0·101	17·2±0·296
Av. quantity of ginning outturn per plant in gms.	2·5±0·048	8·3±0·156

TABLE II (*Contd.*)

*A 3 years' vernalized crop was obtained from seeds collected each season as progeny of vernalized plants and re-vernalized. The programme, thus, lasted for 3 successive generations.

Since the methods of selection and hybridization have their own limitations, the introduction of suitable foreign types has been looming large in crop improvement work. The fact that pre-treatment of seeds can impress upon the embryo a developmental pattern which pre determines the flowering time and also that the process of the preparation of a plant towards reproduction may as well occur in the embryo, makes the successful introduction of exotics in new areas possible.

The Aboriginal Races of India

B. S. Guha

Anthropologist Zoological Survey of India, Calcutta

THE diverse races and tribes that inhabit this country contain a large number who are still in a primitive state subsisting either by hunting, fishing, and on forest produce, or by simple forms of agriculture. We had hitherto no definite information of the total number of these people, but thanks to the initiative taken by Dr J. H. Hutton, special statistics were collected in the Census of 1931 and the figure of 22½ millions in round number was obtained as the total strength of the aboriginal races.[1] This is approximately 6½% of the entire population of India, but if we take into account some of the 50 millions and odd who constitute what have been called the "Exterior Castes" but are in reality mostly detribalised primitive folks in the process of entering the Hindu social system,[2] the actual proportion will certainly be twice or even thrice this figure. We thus see that the aboriginal or the primitive element occupies a large part of India's horizon and should in all fairness receive a corresponding share of her attention. Unfortunately this is not the case and the data that we possess about the habits, customs and physical affinities of these people are neither comprehensive

[1] *Census of India*, 1931, Vol. I, Pt. I, Appendix II.

[2] *loc. cit.*, Appendix I.

nor wholly reliable. We have no central department specially concerned with their interests as exists in the U. S. A., nor have we any permanent machinery exclusively devoted to their studies.

Such information as we possess about these tribes are due to the labours of a few distinguished workers whose investigations had naturally to be limited to special areas. Consequently it is not possible to speak with as much accurate details regarding the racial constitution and social behaviour of these folks as is possible in other countries similarly constituted, beyond a general outline of their somatic features and a broad indication of their place besides other races of the world.

Regionally these tribes may be grouped into three separate zones.

(1) A *Northern and North-Eastern Division* of about 3 million people comprising such tribes as the Limbu, Gurung, Lepcha, Abor, Mishmi, Mikir, Garo, Khasi, Naga, Kuki, Chakma, etc. They are scattered over a very large area consisting of the sub-Himalayan region and the mountainous territories of Assam and North-Eastern India merging imperceptively into those of Burma and Yunnan, and from which no strict line of demarcation either from the geographical or ethnographical standpoints can be drawn.

(2) A *Central Division*, occupying small hills and plateaus which traverse the entire breadth of the country from the Gulf of Cambay to the Orissan coasts. It comprises the Bhil; the Gond, the Kol, the Oraon, the Munda Santal tribes, etc., and is by far the largest group containing altogether about 18 million people.

(3) The third or the *Southern Division* is the smallest and contains a little over 1 hundred thousand people spread over the hills of southern India, specially the ranges along the extreme south-western strip of the peninsula.

There is a rough parallel between the geographical distribution and the linguistic affinities of these tribes. Among the Northern and Northeastern Group the languages spoken belong to the Tibeto-Chinese family with the exception of a small island formed by the Khasi in Assam, and the languages spoken in Lahoul, Chamba and Kanardar not far from the Simla Hills which though outwardly Tibeto-Chinese contain an underlying strain considered by linguists to be 'Austric'[1]

The Tibeto-Chinese languages are essentially isolating or monosyllabic, though among the Tibeto-Burman branch to which the majority of the tribal languages of Assam and Burma belong, the agglutinative principle has now superseded the isolating. The characteristic features of these languages are that they do not possess the "real verb" and are fitted to express concrete ideas only; but with the march of progress and contact with other languages, some of them are also developing at the present time a mechanism for expressing abstract ideas from the concrete.

In the Central Division on the other hand, the languages spoken belong chiefly to the 'Munda' branch of the Austric family, except the Bhil, the Gond, the Oraon, etc., who have adopted Aryan and Dravidian speeches in place of their original mother tongues.

Like Tibeto-Burman, 'Austric' is also agglutinative, but in this language the use of 'suffixes' has developed in an extraordinary degree. Its chief distinguishing trait however is the use of 'inflexes' which no other language possesses to the same extent.

The Southern Group of aborigines now speak entirely Dravidian languages in corrupt forms. It is certain that their original mother tongues were different, either of Austric affinities, or as seems possible among some at any rate, bearing relationship to the languages spoken in the Malay Peninsula or the Andaman Islands. Evidence of the existence of Austric languages has not been found beyond the Ganjam district among the Savaras, and in the absence of any systematic investigation of the tribal languages of southern India we have no means of knowing if any of them still retain an underlying strain other than Dravidian. Incidentally it is a sad reflection on Indian scholarship that no trained Indian linguist has undertaken this work and it has

[1] Griegson, Sir George—*Linguistic Survey of India*, Vol. I. Pt. I, pp. 55-59, 1927, Calcutta.

been left to Dr M. B. Emeneau of the Yale University to come all the way from the U. S. A. to collect first hand materials on Toda and Kadagu in their projected comprehensive study of the Indian tribal languages.

Attention has been drawn to the parallelism between the regional and linguistic distributions of these tribes but this parallelism does not extend to their physical features.

Somatically, they show independent alignments not corresponding to their linguistic divisions. Language, as is well known, is too often abandoned for another, and mention has already been made of the many instances in this country where entire tribes have adopted more forceful intruding languages against which their simpler speeches could not hold their own. Such, however, is not the case with physical characters which are fixed by heredity and cannot be altered except through miscegenation. The greater stability of the physical traits has, therefore, been regarded as a truer basis for racial differentiation; and in the classification of races stress is no longer laid on the language or habitat but on the bodily constitution. The use of philological terms like' Aryan,' ' Dravidian,' or ' Mon-khmer ' in the racial sense, has no authority and is consequently to be deprecated.

Judged by their somatic traits there is first of all an underlying Negrito strain in the aboriginal population of India. At the present time it is no doubt greatly submerged but remnants are still found in remote hills, and from the evidence available there is hardly any doubt that it was much more widely spread at one time. The presence of a Negrito race in almost in its pure form has long been recognised among the inhabitants of the Andaman Islands but its existence in the Indian continent was not considered established. Even so well informed a scholar as Sir Herbert Risley [4] considered that " no good observer had as yet found among any of the Indian races a head of hair that could be correctly described as ' wooly ' although the terms ' wooly ' and ' frizzly ' were often loosely applied to the wavy hair not uncommon among the Dravidians." It is true that the term ' wooly ' is not strictly applicable to human hair: the sheep's wool being of a finer texture and shows the true pile formation which can only be made artificially in man.[5] But instances of spirally curved hair with tiny spirals misnamed ' wooly,' and slightly longer but tightly coiled spirals known as ' frizzly ' are not absent among aboriginal races of this country. As early as 1903-1904 Prof. L Lapicque of the University of Paris and now an illustrious member of the French Academy visited the Kadar settlements at Mount Steward in the Annamalais Hills on a scientific mission sent by the Government of France, and called attention to the existence of a primitive Negroid race among the aborigines of these parts.[6] He found them to be of short stature with black skin colour, ' wooly ' hair (chvelures crépues) and bodily proportions approaching those of the Ethiopians.[7] The cephalic index however was dolichocephalic—a character which in his opinion, distinguished them from the true Negritos.

Unfortunately Lapicque's researches were published in journals not easily accessible to anthropologists and was probably responsible for the comparative ignorance of the importance of his discoveries.

In the course of a survey of the primitive tribes living in the Annamalais Hills and its ranges which extend southwards in the Cochin and Travancore States in the winters of 1928 and 1929, the present writer, then unaware of Lapicque's investigations, independently discovered among the Kadars and Pulyans remnants of a race possessing spirally curved hair.[8] In the majority of cases the hair was found to be similar to that of the Melanesians, consisting of long tightly coiled spirals, but there were also a few who possessed short spirals characteristic of the hair wrongfully called ' wooly '. The average stature of these people is very short (mean-1516 mm.) and the skin colour dark chocolate brown approaching black. The nose is flat and broad and

[4] Risley, Sir Herbert—*People of India*, p. 5, 1915.

[5] Martin, Rudolf—*Lehrbuch der Anthropologie*, Vol. I, p. 214, 1928.

[6] Lapicque, Louis—*Bull. der Mus., D'Hist. Nat., XI*, 283-85, Paris, 1905.

[7] Lapicque Louis—*Comptes rendus des seances de la Societe de Biologie, 58;* 949; Paris, 1905.

[8] Guha, B. S.—*Nature, 121,* 793; 1928; *123,* 942-43, 1929.

not unoften everted. It is true that the head shape of the Kadars in general is dolichocephalic but among the individuals with frizzly hair a marked tendency was noticed for a rise in the cephalic index to mesocephaly. The presence of two individuals with 77·34 and 79·29 as the values of their index, and the recent discovery of a brachycephalic individual with the so-called 'wooly' hair among the aborigines of the Rajmahal Hills[9] would seem to indicate that the basis of the Negritos of India was probably mesocephalic if not brachycephalic like the Andamanese, and not dolichocephalic as Lapicque had thought, but large admixture with a primitive longheaded race had affected the general shape of their head.[10] Somewhat similar conditions appear to have taken place among the Semangs of the Malay Peninsula who are mesocephalic, and it is noteworthy that the designs found in their bamboo combs are identical with those used by Kadar women.[11] We have no definite proof of the presence of spirally curved hair among other aboriginal tribes of southern India though reports of such occurrences among the Irulas[12] and the Wynaad tribes have recently been made. From somatometric and morphological evidence it seems highly probable that among a large section of the primitive tribes of South India, such as the Nattu Malayans, Yeruvas, etc., there has been a large admixture of Negrito blood[13] and it is not unlikely that many more instances of frizzly hair will be found in the extreme interior of these hills if carefully explored.

Outside the Rajmahal hills no instances of spirally curved hair have been reported so far from Upper India, but Hutton,[14] not long ago, drew attention to the presence of frizzly hair among a section of the Angami Nagas. This strengthens the suggestion of their linkage with the Semangs of the Malay Peninsula already mentioned, and possibly also with the Andamanese who seem to have reached their present habitats from the same regions in very ancient times.

The Negrito substratum in the Indian population whose remnants are still found in isolated tracts would thus appear to have been much more widely spread originally but mostly submerged at the present time and in all probability not unconnected with the Nergitos of Malay Peninsula and of the Island of the Indian Ocean, though the latter have preserved in their isolation the characteristic features of the race in a much purer from.

Besides the Negritos, the most important element in the aboriginal tribes of southern and central India is a dark short statured type with long head and broad flat nose. The stature is not so short as that of the Negritos but the skin colour is much the same, varying from tawny to dark chocolate brown. In the shape of the nose and the face there is no appreciable difference, there being the same tendency in the face to project forwards, and in both, the lips are thick and often everted. What distinguishes the latter, however from the Negritos is the form of the hair which in general is wavy and sometimes curly but never frizzly. Various opinions have been expressed regarding the true affinities of this type but when all the somatic traits are taken into consideration, its kinship with the Australian race seems undoubted. It is true that the 'keel' so commonly found in the Australian skull is absent in it and the amount of facial and bodily hair is not like anything so profuse as among the typical Australian. In general also, though the supra-orbital regions are well marked, the depth of the nasal root and the formation of the lower forehead are not so characteristic as among the Australian, though in an appreciable number the supra-orbital regions are equally stout and the nasal root shows the same sunkenness. In other characters, however, such as stature, form and proportions of the head, face, the nose and the skin colour, the resemblances to the Australian aborigines are very striking.

In a recent study of the anthropometry of the Australian tribes Dr W. W. Howells[15] has discussed their affinities with the primitive races of Melanesia, Indonesia and Asia, and after a careful comparison

[9] Sarkar, S.—*Nature*, *137*, 1035, 1936.

[10] Guha, B. S.—The Racial Affinities of the Peoples of India. *Census of India*, Vol. I, Pt. III, pp. I-li, 1935.

[11] Preuss, Dr K. Jh—*Globus*, Vol. LXXV, pp. 345-348, 364-369, 1899.

[12] Hutton, J. H.—*Census of India*, Vol. I, Pt. I, 1935.

[13] Guha, B. S.——*loc. cit.*, pp. xlviii-xlix, 1935,

[14] Hutton, J H.—*Man in India*, Vol. VII, pp. 257-262, 1927.

[15] Howells, W. W.—*Papers of the Peabody Museum*. Harvard University, Vol. XXVI, No. I, pp. 59-67, 1937.

Photographs of some of the types of the Aboriginal Races of India

Fig. 1.
Kadar

Fig. 2.
Kadar

Fig. 3.
Kadar

Fig. 4.
Kadar

Aboriginal types of India.
The Negrito type (Figs. 1-4).

Fig. 5.

Fig. 6.

The Proto-australoid type (Figs. 5-6).

Fig. 7.
Lepcha

Fig. 8.
Lepcha

Fig. 9.
Limbu of Nepal

Fig. 10.
Limbu of Nepal.

Fig. 11.
Bhutanese

Fig. 12.
Bhutanese

Mongoloid type (Figs. 7-12).

of their physical characters has come to the conclusion that their closest correspondence is with the Veddahs of Ceylon. With the Indian tribes such as the Chenchus of southern India, while in form and proportions the resemblance is strong, the absolute dimensions are somewhat larger in the Australians, specially the facial breadth. It is true that the face as whole is much narrower among the Indian tribes but it is not uniform in the Australian tribes either, and in one at least, namely, the North Central Australians, the maximum breadth of the face was found by Spencer and Gillen to be 134. 81 against 131.2 of the Kols,[16] 131.70±0.17 of the Mundas[17] and 132.07±0.4 of the Malpaharias.[18] When all the characters are considered there appears to be a regular gradation in these three racial groups—the Australians are the largest and show the characters in the most pronounced form, then come the Veddahs and lastly the Indian tribes. Except for their comparative smallness, the likeness between them is unmistakable and there cannot be any doubt about the existence of a genetic relationship between the three.

Sewell and the present writer[19] therefore, have thought it more appropriate to describe them as *Proto-Australoid* which suggests the presence of the chief somatic characters of this racial family in a less developed form, and there seems no justification for calling them "Veddoid" when we consider, as shown by Howells,[20] that the resemblance of the Veddahs is much greater with the Australians than with ony of the Indian tribes. Still more unfortunate is the use of such expressions as "Pre-Dravidians," which if anything merely gives a chronological sequence to the unauthorised application of a linguistic term in the racial sense.

This Proto-Australoid type is the dominant element among the aborigines of central and southern India. We have no precise information of the earliest drift of this race in India, but in the ancient sites at Aditanallur in the Tinneyvelley district of south India its remains have been found.

In the early Sanskrit literature also there are frequent mention of a race of aborigines generically referred to as "Nishads",[21] whom the Vedic settlers encountered in their expansion south-eastwards. The descriptions given of their physical characters leave no doubt that the Proto-Australoids were meant, with whose distinguishing features they appeared to be well acquainted.

Judging from their present distribution the Proto-Australoid tribes appeared to have come later than the Negritos and pressed them gradually into the marginal and less hospitable parts in which their remnants still survive today, though in the process of this a great deal of their blood was gradually absorbed. There is no doubt that the Proto-Australoid element is not confined to the aboriginal population only but has entered very considerably in the Indian population in general. Indications are not wanting also that even in the sub-Himalayan and the northeastern frontier countries where the Tibeto-Chinese speaking tribes are encountered at present, there is an underlying substratum of this element in several places. But the chief racial constituents in these regions are essentially Mongoloid and conform to two distinct bio-types, namely a round headed one which is tall and large bodied in the north, specially in Sikkim, and in Bhutan, where Tibetan infiltration has taken place, and short and small in the southeastern parts of Bengal bordering on Burma. In the former subtype the skin-colour is light brown and the eyes are slitlike with marked presence of the epicanthic fold. The nose though flat is narrow and long and both the head and the face are round. Like the body the head is massive and the absolute dimensions are greater than any other race living in this country. The other sub-type is darker in skin colour and much shorter in stature. The head is also round but smaller and the epicanthic fold is less marked. The nose is broader and shorter and there is not infrequently a tendency for the face to protrude for-

[16] Chatterjee, B. K.—Unpublished materials.

[17] Basu, P. C.—*Trans. Bose Research Institute*, Vol. VIII, p. 224, 1933.

[18] Sarkar, S.—*Trans. Bose Research Institute* Vol. XI, p. 149, 1936.

[19] Guha, B. S.—*An Outline of the Racial Ethnology of India*, p. 131, 1937.

[20] Howells, W. W.—*loc. cit.*, p. 67

[21] Chanda, Ramaprasad—*The Indo-Aryan Races*, pp. 4-6, 1916.

wards, though nothing like the extent found among the Negritos and the Proto-Australoid tribes.

Compared to the former also the vault of the head is lower and the face shorter. This sub-type is undoubtedly more primitve, and may appropriately be called *Palae-Mongoloid*. Though the main distribution of this sub-type is in Burma and the mountainous regions adjoining that country, it has penetrated well into Assam and is not altogether absent in the sub-Himalayan regions specially among the primitive races of these parts like the Lepchas.

The second Mongoloid element is of medium stature with a skin-colour darker than that of the Tibetan but lighter than that of the Palae-Mongoloid. The characters of the eye and the facial cast are essentially Mongoloid but the epicanthic fold is not so conspicuous as among the Tibetan group. Its chief distinguishing feature, is the form and shape of the head. The back of the head is neither flattened nor rounded among the truly brachycephalic races, but bulges outwards. The breadth is also smaller and its proportion to the length is less. Though the actual values of the cephalic index often come within mesocephaly the essential long-headed character of the race cannot be doubted. This was recognised by Sir William Turner[22] as early as the beginning of this century and all subsequent studies have confirmed the conclusions reached by him regarding the headshape of the Assamese hill tribes, though no doubt the Palae-Mongoloid strain, which forms a constituent of heir composition is responsible for a rise in the cephalic index noticed in many parts occupied by these tribes.

Compared to the tribes of central and southern India, the Mongoloid tribes of northeastern India are more recent and are mainly concentrated in these parts, but it would not be wrong in stating that their influence has also penetrated into the main land of India as judged from the presence of undoubted Mongoloid features among many people. It is however true that this penetration is still mostly confined to the districts contiguous to their habitations and is not so deep and extensive as is the case with the Proto-Australoid race.

I have so far discussed the different racial elements in the Indian aboriginal tribes from the anthropometric standpoint. In recent years considerable advance has been made in the study of blood group distributions of various races. It is as yet too early to assess the full significance of these studies, though the results so far obtained do not indicate any close correspondence between the results of anthropometric investigations and the blood group differences; but there is no doubt that these biochemical differences are determined by heredity and are of great value in investigations of racial differences. It would, however, be a mistake to regard them as supplanting the findings from morphological studies but rather as supplementary to such works as they provide important additional criteria.

In India, agglutinogen tests have been made on a few primitive groups, namely, the Paniyans of Wynaad,[23] the Illuvas of Cochin,[24] the Hill Males, Santals and Oraons of central India,[25] and small groups of the Nepalese and Lepchas of the Darjeeling district.[26] The data though small are very suggestive and indicate a clear divergence between the south Indian and central Indian tribes. In the former there is a marked preponderance of the blood group A—the percentage among the Panyans being as high as 60.40 [23] it is interesting that this is very similar to that of the central Australian tribes among whom Cleland found the percentage of A to be 61.9.[27]

Among the central Indian tribes on the other hand the Santals[28] show a considerable preponderance of B over A, a feature that is also true of some of the depressed castes of Bengal,[29] *e.g.*, the Bagdis who show a blood group distribution closely parallel to that found among the Santals. The Hill Males[28] and the Oraons[28] show a slightly lesser preponderance

[22] Turner, Sir William—*Trans. Roy. Soc. Edin.*, Vol. 39, pp. 700-749, 1900.

[23] Aiyappan, A.—*Current Science*, pp. 493-94, 1936.

[24] Macfarlane, E. W. E.—*Ibid.*, pp. 653-54, 1936.

[25] Sarkar, S.—*Ibid.*, p. 283, 1938.

[26] Macfarlane, E. W. E.—*Man*, 159, 1937.

[27] Cleland, J. B.—*Science*, Vol. 77, pp. 260-61, 1933.

[28] Sarkar, S—*loc. cit.*, p. 283, 1937.

[29] Macfarlane, E. W. E.—*Journal of Genetics*, 36, 2, 193-

of B over A than the first two as well as low percentage of agglutinogen B. A plausible explanation may be found in the fact that the latter are both Dravidian speaking and they probably migrated from south India in comparatively recent historical times.[30]

Among the Mongoloid peoples of the Darjeeling district the proportions of the blood group frequencies are not quite similar to either of the last two but rather to those of the Chinese.[31] There is not the preponderance of B that is found among the central Indian tribes, but the proportions of the three blood groups are about equal though they are closer to the north Indian conditions[32] than to those of southern India.

These results are not contradictory to those obtained from anthropometric studies but tend to support the contention that the south Indian tribes retain more the original conditions of the Proto-Australoid race in which there was a scarcity of agglutinogen B, as shown when comparisons are made with the Australian tribes. If, as some workers postulate, the mutation to B occurred in central India, this happened after the present south Indian tribes had separated from their main stock in central India. The lower frequency of B among the two Mongoloid races of the Darjeeling district is probably due to their isolation from the centre of mutation to B in central India—they having received the agglutinogen B from a different centre of mutation in China where the mutation rate was apparently lower and from where it has spread west and southwards in Assam, Burma and the Himalayan regions.[33]

To conclude, we find four major strains in the aboriginal population of India, namely, (*i*) an underlying substratum of a primitive Negrito race which is found in comparative purity. among the Andamanese and the Semangs of the Malay Peninsula but its wide presence at one time in the main land of India is indicated by the survival of small remnants in isolated tracts of different parts of India, (*ii*) a Proto-Australoid race having close affinities with the Veddahs and the aboriginal tribes of Australia which arrived subsequently and pushed back and absorbed the Negrito tribes and now forms the dominant element in the central and south Indian tribes. These two constitute the chief racial elements in the primitive population of central and south India with a shade of Mongoloid admixture here and there, though the latter remains distinct from the two groups and is composed of (*iii*) a brachycephalic element divided into a more primitive short, and an advanced tall large bodied sub-types. These are found mostly in the sub-Himalayan regions and Burma and are distinct from (*iv*) the medium statured dolichocephalic element which is chiefly distributed in the Assam hills mixed no doubt with short statured Palae-Mongoloids.

The Mongoloid races arrived last and though contributing to some extent to the racial make-up of the Indian population, have in the main remained distinct and confined their influences to the regions adjoining their habitations.

[30] Venkatachari, C. S.—*Census of India*, XX, App. II, 267-79, 1931.

[31] Macfarlane, E. W. E.—*loc. cit.*, 1937.

[32] *Ibid.—Journal of Genetics, 36*, 2, 1938.

[33] Macfarlane, E. W. E.—*Abstracts of Discussions, Ind. Sc. Cong.* Calcutta, p. 34, 1938.

Water Hyacinth—A Problem for Bengal

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WATER hyacinth (*Eichhornia sp.*) an indigenous water plant from Brazil attracted by its beautiful lilac flowers was brought to India by some stray traveller as an ornamental plant for the garden tanks, and has now become one of the most serious pests in our country and specially in Bengal where the vast stretches of water, tanks and waterways have provided an ideal place for their propagation. The silting of river beds, the choking of the natural flow of the rivers, stagnation of water stretches by railway embankments and lack of proper irrigation system have all unconsciously and gradually facilitated the propagation of this water plant. In villages where tank water is consumed, the infection of this pest has led to deterioration of general health and vitality of the people. The stagnant water with decaying organic matters has become an ideal place for mosquito breeding. Due to the rapid vegetative growth of water hyacinth the rice fields, in Eastern Bengal particularly, have also been infected and it is now a serious problem to tackle with.

The Bengal Government recently organised a water hyacinth week for propaganda and for eradication work of this unwanted pest. It is necessary that this problem should receive the sincere attention of the villagers because the solution of this problem is possible only with the active support of those who suffer the most. But how far are the poor villagers able to support any scheme is the question, without the Government finances at the back and initiation of the scheme on nation-wide scale? Water hyacinth problem is a pretty old one in Bengal and it has baffled all the efforts of eradication upto this time because no systematic scheme has yet been adopted and moreover no efficient method is known to successfully eradicate it. But it is certain that piecemeal efforts would lead nowhere. It is therefore very essential that in these days of national reorganisation and rural uplift serious efforts on a well planned scientific basis should be made to rid Bengal of this obnoxious pest. More than two years of scientific research on water hyacinth problem in Orissa [1] has convinced the writer that there is no other way to tackle this problem except to study the physiological and agronomical behaviour of the plant and to apply such knowledge as accumulates to adopting some efficient and constant mechanical means to check its propagation and successful eradication.

It is generally believed, and rightly so, that water hyacinth propagates vegetatively *i.e.*, any portion containing a piece of stem can give out roots and form new plants, or by giving out runners which can produce innumerable plantlets which get separated from the mother plant by wind or water current and each continues as a separate floating plant repeating the same vegetative propagation. Therefore if a tank or a stretch of water is thoroughly cleared of its water hyacinth we should not expect any more water hyacinth in it unless it is contaminated again from outside. But in field experiments the result is found to be different because water hyacinth propagates by seeds also. By clearing the floating plants alone, we cannot, therefore, expect to check its propagation. The seeds which are ridged and borne in a capsule are very minute, about 21/16 mm. in length, and the diameter at the thickest zone being 12/16 mm. The spike which bears capsules containing the seeds, bends and discharges the ripe seeds into the water, which sink down. It was been found that such seeds remain viable even for a period of five years or more. Therefore there will always be a source of supply of water hyacinth seedlings in a tank from which all floating plants have been cleared off. This important fact needs attention.

[1] Ind. Journ. Agr. Sc. Vol. IV. 1934.

WATER HYACINTH—A PROBLEM FOR BENGAL

The seeds germinate when favourable conditions occur. The seeds may avail of conditions conducive to their germination in various ways. In tanks or places which are periodically flooded and shelter water hyacinth the seeds embedded in the mud dry up with the coming of the dry season and germinate with the coming of rains. The seeds which drop or rest on the sides of the tank find an opportunity to germinate when the water recedes. The water hyacinth which encroaches into the rice fields germinate when fields are again flooded and brought under cultivation. The seeds germinate on the surface of the soil at the beginning of rains or whenever the humidity, soil moisture and temperature are suitable. The seedlings begin their life as land plants, fixing themselves in the soil and when the fields are flooded or submerged they float up, breaking away from the root stock with the help of their developing leaves, which serve as a sort of paddles and begin their existence as floating plants. The seedlings have remarkable power of surviving submersion.

The adult plants are capable of growing under varied conditions. They resist a considerable degree of drought and can thrive in a wide range of hydrogen ion concentration. It has been tried to eradicate them by using inorganic chemical poisons but vastness of the problem and practical difficulties stand in the way. It is found that plants growing in a sub-lethal solution tolerate concentration which are lethal to 'uneducated' plants.

The behaviour and the nature of the water hyacinth plant as described above clearly show that systematic eradication work should be done in proper season to produce effect. Water hyacinth sets seeds only in the autumn *i.e.*, in October and November. We can take advantage of this fact by introducing eradication work before the plants shed their seeds into the water *i.e.*, water-stretches should be cleared before the end of September. This will minimise to a large extent the incidence of propagation through seedlings and ultimately vegetative propagation. Definite areas should be selected and put under observation. As our knowledge stand at present, no other efficient method of eradication except mechanical is possible and when labour is so cheap, a well-planned scheme gone through in proper season would certainly lead in time to complete check and successful eradication of this plant. When by human labour forests are cleared, deserts are brought under cultivation, fresh land is recovered from sea, it is also possible by proper organisation to get rid of this pest in Bengal.

Mathematics in Irrigation

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"WHAT has mathematics got to do with irrigation?" This question has been put very often not only by laymen but even by mathematicians themselves. Before showing how intimately does mathematics, even higher mathematics, enter into every phase of irrigation, I shall explain how irrigation is practised in one of the premier irrigation provinces of the world, namely, the Punjab. It is well known that there is not a single river in the Punjab that has not been tapped for the purpose of irrigation. The river Jhelum has been tapped twice, the Chenab three times, the Ravi three times, the Beas and the Sutlej four times and the Punjnad (where the five rivers join) once. Even the Jumna which forms the eastern boundary of the province has not been neglected. The rainfall in the Punjab is scanty, specially in the regions away from the hills, but fortunately its rivers carry enough volume of water. Most of them have their

origins in the glaciers of the Himalayas and their supply rises considerably in advance of the monsoon and persists much later. So starting from the middle of March when the rivers are snowfed there flows

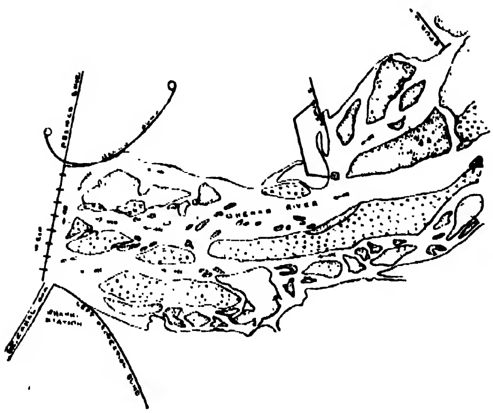


Fig. I.

a steady stream of water through these rivers right to the end of October, sometimes even to the middle

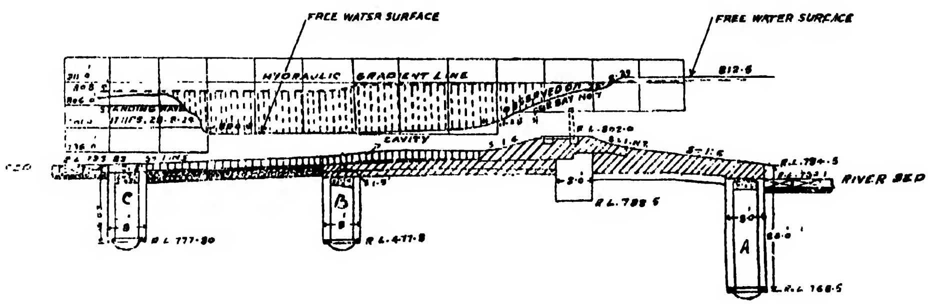


Fig. II.

...ber when it is generally the seepage water ... hills - the monsoon rainfall in the hills ...ad percolated into mountains and submontane ...ts oozing out and feeding the rivers after the monsoon is over. This steady supply from the middle of March to the middle of November is utilised for the purpose of irrigation by building a weir or a dam across the river. A weir or a dam is a masonry structure built across the river to head up the supply in the river. The level of water upstream of this weir is maintained and manipulated by a series of gates or shutters on the weir so that by raising and lowering as many of these gates or shutters as much water is let down the river as is thought necessary and the upstream river level is maintained at such a height that proper supply can be fed into the canals that take off upstream of the weir. Fig. I shows the river Chenab above the weir at Khanki where the biggest canal system of the Punjab takes off, the Lower Chenab Canal. It shows the weir that had been built here in 1892-96 to supply water to one of the richest colonies of the Punjab, the Lyallpur colony. The whole span of the river is about a mile and a masonry bund had been put across the river so that when the river is low, gates and shutters are used to head up the river. This creates a vast pond upstream of the weir which supplies water into the canal during periods of low discharges in the river, *i.e.*, in the months of December, January and February. Sometimes even during January and February a sudden freshet comes in the river and the pond is replenished.

The masonry structure that ponds up the water is generally built on the beds of the rivers that are mostly sandy in India. Fig. II shows the longitudinal section of such a structure built on the river Chenab at Marala. It will be seen from this figure that this structure consists of reinforced concrete work shown shaded by slanting lines resting on the sandy bed of the river. It will be seen that in the highest part of this structure known as the crest there is a shutter shown down, its erect position being marked dotted. There are three vertical

structures marked A, B and C—they are known as lines of wells. I shall explain later on their functions; they are now being replaced by sheet piles as the latter are more efficient than the wells. The two wells A and C together with the shaded concrete portion form one unit built on the alluvial bed of the river. On the upstream and downstream of this unit there are heavy concrete blocks laid in layers on dry stones resting on sand. The top levels of these blocks are flush with the bed levels of the river and the level of the crest is about 10 feet higher. So that with the help of the shutters about 16 feet depth of pond may be obtained in rivers of low supply. When there is a flood passing in the river the shutters are laid down and due to the height of the crest alone the river level upstream is raised to something like 20 feet above the bed of river. It will be seen from Fig. III(*a*) that the river is flowing over the crest and on the down stream side where there is a sloping floor a jet of water with high velocity shoots down the inclined floor. Now the depth of water on the downstream side of the weir depends on the conditions of the river below the weir. Here the slope of the river is flat and the depth of water correspondingly more, so that the fast moving jet of water coming down the sloping floor meets the slow moving mass of water of the natural river. There is a violent impact where lot of turbulence is created and unless this impact takes place on the concrete structure the sandy river bed will not be able to stand all the turbulence thereby produced and big scour holes will be created which will make the structure of the weir very unsafe. This impact and the subsequent turbulence is technically known as "Standing Wave". It has got the appearance of a forthy mass of water being generated every second and dying out as it flows down the river. It is, therefore, very essential to know where this Standing Wave will form and how far its effect will extend downstream for different river conditions, because it is absolutely necessary to keep the whole length of the standing wave on the floor and it must not be allowed to extend beyond the downstream blocks. Moreover the point where the Standing Wave forms must remain on the sloping floor as otherwise on the horizontal floor its position is very unsteady. Herein comes mathematics to the help of engineers. The theory of Standing Wave is as follows: Fig. III shows diagrammatically the formation of a Standing Wave. *abfe* represents a mass of water moving through the Standing Wave. In

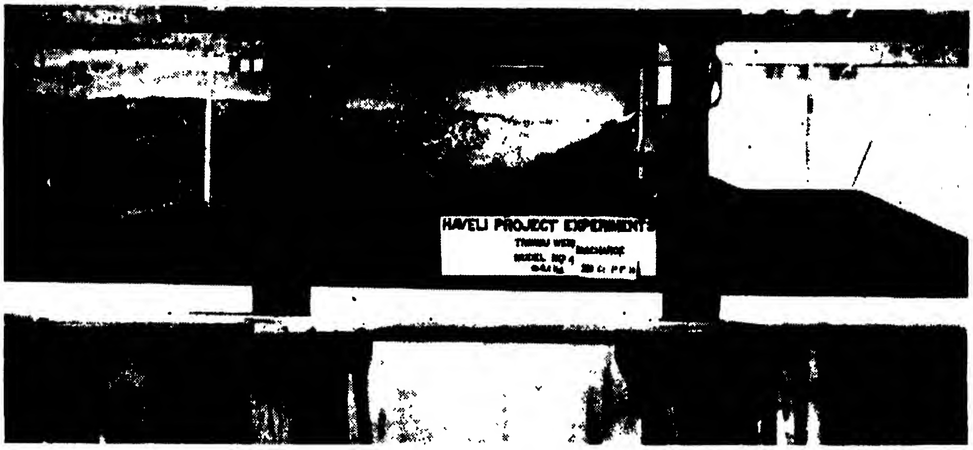


Fig. III. a.

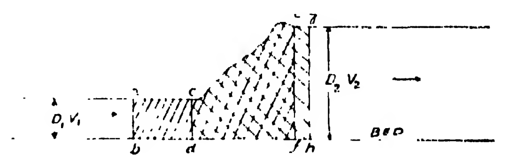


Fig. III.

a short interval of time it is supposed to move to the position *cdhg*. The Standing Wave has the following characteristics:

(*a*) The water entering at *ab* has a nearly uniform steady high velocity and is transparent.

(*b*) The water leaving at *gh* has fairly uniform but relatively low velocity and is transparent.

(*c*) Between *c* and *e* the surface rises rapidly and is much disturbed by spraying and spattering. The whole mass is so milky as to suggest the presence of much internal impact. The milky condition of the water reduces its specific gravity and accordingly th surface at the top of the rise is above the normal level, but as soon as all the air bubbles reach the surface so that the water is again transparent, the surface becomes smooth and level.

The mass of water loses momentum in passing from the position *abfe* to the position *cdhg* and according to Newton's Second Law of Motion the rate of loss of momentum must be equal to the unbalanced force acting on the moving mass to retard its motion.

Against the face *ab* is the static pressure of the water acting towards the right. Opposed to this force are the static pressure acting against the face *ef* and the surface friction along the bottom *bf*. The latter is small and may be neglected.

If q be the discharge per unit width of the channel

$$q = V_1 D_1 = V_2 D_2$$

Mass per second $= \frac{W}{g} q$

Change of momentum per second $= \frac{W}{g} q (V_1 - V_2)$

Change of pressure $= \frac{1}{2} W (D_2^2 - D_1^2)$

$$\therefore D_2^2 - D_1^2 = \frac{2}{g} q (V_1 - V_2)$$

Substituting q/D for V we get:

$$\therefore D_1 D_2 (D_1 + D_2) = \frac{2}{g} V_1^2 D_1^2$$

$$\therefore D_2 = -\frac{1}{2} D_1 \pm \sqrt{\frac{2}{g}\frac{q^2}{D_1} + \frac{1}{4} D_1^2} \text{ and}$$

$$D_1 = -\frac{1}{2} D_2 + \sqrt{\frac{2}{g}\frac{q^2}{D_2^2} + \frac{1}{4} D_2^2}$$

At this point it is necessary to introduce a new conception that of critical depth. For every discharge q there is a critical depth and critical velocity for which the energy of flow is minimum. It can be shown from hydrodynamics that the critical depth D_c is given by:

$$D_c = \sqrt[3]{q^2/g}$$

Substituting $x = \frac{D_1}{D_c}$ and $y = \frac{D_2}{D_c}$ we get

$$xy(x + y) = 2$$

Denoting by H_2 the loss of energy through Standing Wave we get:

$$H_2 = \left(D_1 + \frac{q^2}{2g} \cdot \frac{1}{D_1^2}\right) - \left(D_2 + \frac{q^2}{2g} \cdot \frac{1}{D_2^2}\right)$$

$$= \frac{(D_2 - D_1)^3}{4 D_1 D_2}$$

Substituting

$$z = \frac{H_2}{D_c} \text{ we get}$$

$$z = \frac{(x - y)^3}{4xy}$$

This analysis is due to Crump. So that knowing q and H_2, D_1 and D_2 can be determined accurately for which the Standing Wave will take place. This determined the position of the Standing Wave. This gives the engineer the water surface profile over the masonry structure for any discharge and downstream river level. This is given by the full line shown in fig. II.

I have mentioned previously that the weir is a concrete structure built on the alluvial bed of the river. Upstream and downstream of the lines of wells A and C, (fig. II) there is sandy bed and river water can percolate through it. It will be seen that there is about 20 feet head of water on the upstream side where the bed is pervious so that water will go through the crevices of the blocks and travel along the impervious outside of the well A and then turning round the corner of the well go up along the inside of the wells and hug along the underside of the impervious concrete floor. As sand

offers great resistance to the movement of water the pressure under which the river water entered the sand bed through the crevices of the concrete blocks will be gradually dissipated till water comes out of the blocks on the downstream end. If we follow the path of the stream line that enters the sand adjacent to the well A then it will be seen that this stream total pressure at the entrance end of the stream line hugs the concrete structure of the weir and exerts a pressure on it which is the residual of the total pressure at the entrance end of the stream line. If the pressure at every point of the underside of the structure is plotted as in fig. II it is known as the Hydraulic Gradient Line so that (*b*) the upward force. In fig. II, the disastrous effect of having (*b*) greater than the combined value of (*a*) and weight of the structure is apparent. The floor near the well line B was lifted and what might have cost lacs of rupees in repairs was only averted by the shortness of the flood.

How can one therefore calculate the hydraulic gradient line correctly and knowing this line and the profile of the free water surface design the thickness of the structure accordingly? Fig. IV shows in outlines the underside of a weir structure which is in contact with pervious sand. The sand below the structure is saturated with water which flows from the upstream end of the weir through the sand to its downstream end.

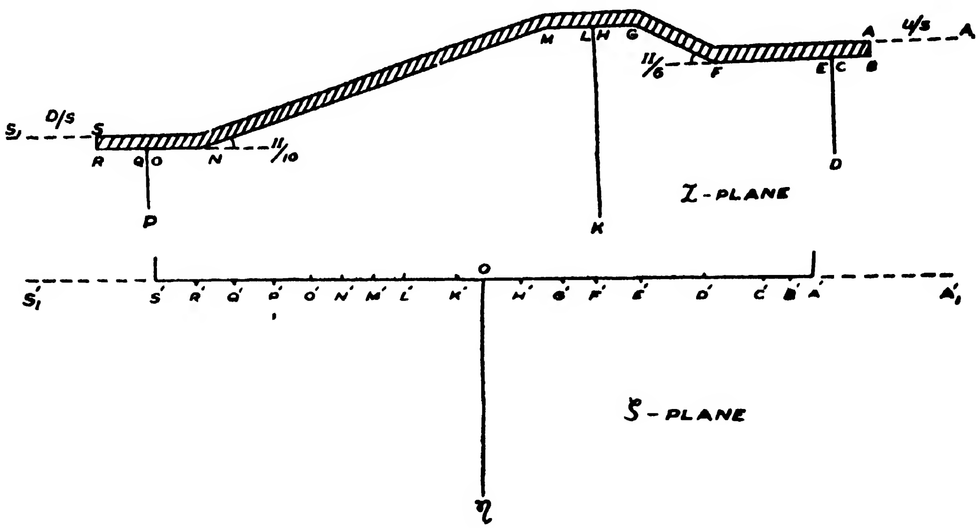


Fig. IV.

the hydraulic gradient line gives the upward thrust of the subsoil flow on the weir structure. Every point therefore of the weir is subject to two forces:

(*i*) Downward force due to the weight of the superincumbent layer of water.

(*ii*) Upward force due to the subsoil flow.

The weight of the structure must be such as to counteract the difference of these two forces.

We had seen previously how mathematics helped to find (*a*) the downward force. Again mathematics came to the help of engineers to find

Darcy, a French engineer, had found from experiments that when water flows through such a porous medium as the sand, the velocity of water at any point is proportional to the pressure gradient at the point. So that

$$V = K\frac{h}{l}$$

where K is a characteristic of the sand known as the Transmission Const. If u, v, w be the three components of velocities at any point (x, y, z), then

$$u = K\frac{\delta p}{\delta x}$$

$$v = K\frac{\delta p}{\delta y}$$

$$w = K\frac{\delta p}{\delta z}$$

and the equation of continuity will give:

$$\frac{\delta u}{\delta x}+\frac{\delta v}{\delta y}+\frac{\delta w}{\delta z}=K\left(\frac{\delta^2 p}{\delta x^2}+\frac{\delta^2 p}{\delta y^2}+\frac{\delta^2 p}{\delta z^2}\right) \quad O$$

$$\therefore \quad \nabla^2 p=0$$

So that the liquid pressure inside such medium will be governed by Laplaces' law. Now I think the problem appears to be familiar to mathematicians. In fig. V below the structure marked by ABCDEFGHIKLMNOPQRS, the pressure distribution in the medium follows Laplaces' law; so that in a two dimensional region given by a longitudinal section of the weir as shown in fig. IV the stream lines and the lines of equal pressure form an orthogonal of curves both satisfying the Laplaces' equation. Now the problem is to find the pressure distribution and stream lines in a region which extends to infinity on one side of the boundary ABCD..........RS in fig. V. A transformation which is familiar to every student of hydrodynamics is known as Schwarz-Christoffel Transformation which will transform the boundary ABCD......RS given in fig. IV to a straight line A'B'C''....R'S' in ζ-plane. In such a transformation the system of pressure and stream lines will continue to cut each other at right angles. This transformation is given by the following equation:—

$$Z=A\int \frac{dz}{(z-z_1)^{\lambda_1}(z-z_2)^{\lambda_2}\ldots\ldots\ldots(z-z_{17})^{\lambda_{17}}}+B$$

where $\lambda_1\pi, \lambda_2\pi, \ldots\ldots \lambda_{17}\pi$ are the changes in the angle at the vertices ABCD............RS as one traverses along the sides of the polygon A_1 ABCD........RS in the positive sense. ζ_1, $\zeta_2, \ldots\zeta_{17}$ are the co ordinates of the points A'B'C''D'....R'S' in ξ-plane, on which the point ABCD........RS of the Z plane map. For the boundary given in fig. IV this integral will be a very complicated one and only be completely solved by model experiments. The boundary in fig. IV can be split up into simpler component parts and simpler integrals obtained and solved for these cases. (See fig. V). The problem

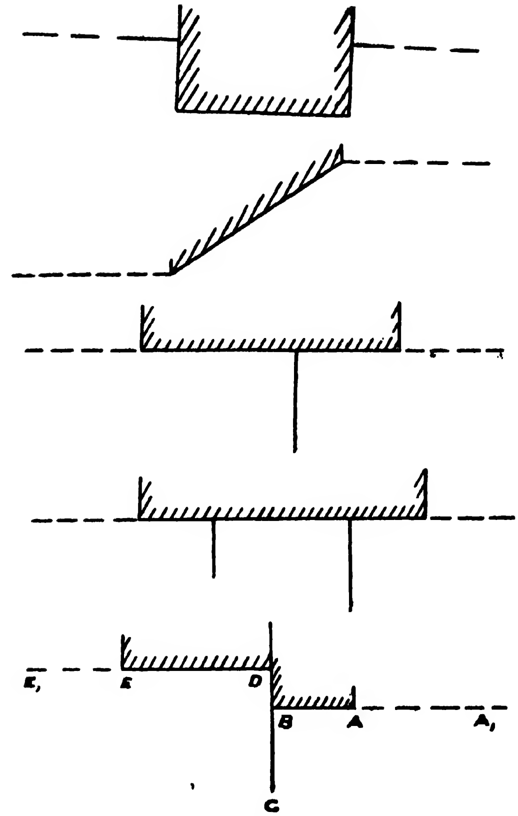


Fig. V

is now reduced to finding the stream lines and pressure distribution round a plane boundary given by A'B'C''........R'S'. This is well known in hydrodynamics. The stream lines are known as ellipses and the equi-pressure lines are confocal hyperbolas given by:

$$\zeta = \xi + i\eta = \frac{b}{2}\cosh w$$

Now knowing the transformation from the Z-plane to the ζ-plane, *i.e.*,

$$Z = f(\zeta)$$

$$\text{or} \quad \zeta = F(Z)$$

and also the stream lines in the ζ plane

$$\zeta = \frac{b}{2}\cosh w,$$

it is quite easy to express Z in terms of W *i.e.*,

$$F(Z) = \frac{b}{2}\cosh w$$

After equating the real and imaginary parts the solution is complete. This has been done by Bose and Malhotra in almost all useful cases and the hydraulic gradient line has been obtained for different structures.

The problem of "Design of Weirs" is now completely solved and mathematics has been mainly instrumental in solving it.

The weirs with its various parts form what is technically known as the "Headworks" of a canal system. This is really the head that governs the whole system and if anything goes wrong with it the entire system suffers. In the past, failures had been frequent in the headworks necessitating repairs costing heavy expenditure and canal closures causing heavy loss in revenue. It is hoped that the new headworks that are now being built on these principles will be free from such costly failures.

I have only dealt with one aspect of the problem. In Irrigation, in the design of canals and falls, in silt movement, mathematics can be of great help in clarifying and solving many other problems that have uptil now baffled irrigation engineers' unaided efforts.*

Lecture delivered at the Mathematical Society of the Islamia College, Peshwar.

The Supermicroscope—A New Aid to Vision

B. N. Ghosh

As early as 1000 A.D., human mind was directed towards artificially extending the vision of the normal eye into the realm of minute and otherwise invisible objects by appliance of glass lenses. The normal human eye is capable of discerning fine films, fibres, thin blades or sizes of the order of 10^{-2} cm. or somewhat less. A simple magnifier brings within vision tissue structures and objects of size 10^{-3} cm.

Microscopy orginated about 1650 A.D. Antony Leewenhoek of Holland sometime janitor of the hall of Delft, was gifted with inventive temperament and had a curious hobby of grinding lenses which became very soon of the best quality available in Europe or even in the whole world. When he was born, there were only crude hand-lenses and there was nothing of the sort of a microscope. Leewenhoek used his lenses for looking through at ox-eyes, sheep-hairs, fly heads and the like. He arranged his lenses to form what may be called the first microscope with which he examined scrapes of tooth-stuff and he was thrilled to find animalcules therein. Accordingly, Leewenhoek is sometimes called the first of the 'Microbe Hunters.'

The microscopic visibility extends over micronic particles of diameter 10^{-3} cm. to 10^{-5} cm., occurring in ordinary suspensions *e.g.*, colloids.

Further attempts to extend the microscopic vision were made by R. Zsigmondy, who invented the 'Ultramicroscope' at the beginning of the twentieth century. This development has rendered visible sub microscopic particles of diameter 10^{-5} cm. to 5×10^{-7} cm., such are the particles suspended in the colloidal solutions.

The latest triumph in the field is the invention of the 'Supermicroscope' or more literally the 'Electron Microscope' which can be looked upon as a splendid tool in exploring the invisible realm. The instrument is a tangible embodiment and a visualised picture of the undulatory aspect of a moving electron. The pioneering work in this

connection dating 1932, is due to M. Knoll and E. Ruska of Berlin.

Microscopy

By means of the well known arrangement of the objective and the eye-piece, the compound microscope presents to the eye of an observer an inverted virtual image of a minute body. If, however, a photographic ocular is used, the primary real inverted image of the object, formed by the objective, is projected upon a screen or photographic plate as an erect real image.

If we want a faithful view of the object, the aperture of the objective is to be sufficiently reduced in order to eliminate the familiar aberrations. On the other hand, owing to diffraction phenomena, very narrow pencils of light rays produce poor images. In fact the finite wave-length of the illuminating light causes the image to be diffuse when the aperture is small. To avoid this effect, the aperture should be large. So a sort of compromise between the two conflicting principles is made in designing the objective and this explains why complicated lens systems are used so that large apertures are obtained without the consequent effect of spherical aberration or blurring at the edge.

The important factors in connection with the microscopic vision are the 'Magnification' and the 'Resolving Power.' The total magnification is the product of the initial magnification of the objective M_o with regard to the object itself, and of the final magnification M_e by the eye-piece of the primary image. According to the older view, $M_o = L/F_o$ (L = optical tube length and F_o focal length of objective), $M_e = 1 + D/F_e$ for the accommodated eye and $M_e = D/F_e$ for the unaccommodated eye, (F_e focal length of eye-piece, and D the conventional least distance of distinct vision or 25 cm.). So total magnification is: $M_o \cdot M_e = L.D/F_o.F_e$. But from the view-point adopted by E. Abbe, $M_o = D/F_o$ and $M_e = L/F_e$; the total magnification therefore remains the same.

The average eye can just distinguish two point objects lying at the least distance of distinct vision, as two different entities when the point objects are at a distance of 0.1 mm. or 10^{-2} cm. apart. The microscope reduces this limiting distance of approach. The resolving power of a microscope, that is, its capacity to show details, is measured by the smallest distance between two minute objects such that their image in the microscope can be just interpreted as due to two distinct bodies; for if their approach is closer, their images merge in each other and hence their double nature is no longer revealed. This limiting value of the distance of nearness d, between two point objects or in other words, the limit of resolution is expressed by $d = \lambda_o/N.A.$, for axial illumination, as put forward by Lord Rayleigh. (λ_o = wave-length of illuminating light in air; $N.A.$ numerical aperture, which is estimated by $\mu \sin \alpha$, in which μ is the refractive index of the medium between the object and the objective and α is half the aperture angle *i.e.*, the angle between the extreme marginal rays which could enter an objective from any one object-point). But E. Abbe showed that utmost resolution, which is exactly half as much is obtained with most oblique illumination. So in this case, $d = \lambda_o/2(N.A.)$.

To obtain a real image, the object must be illuminated with a solid axial cone of light. However, the image due to oblique illumination is not necessarily a true representation of the object. Such an image is, at most, no more than an indication of the periodicity of structure, as expected for objects like a diffraction grating or the diatoms and this indication constitutes the only point of similarity between the object and its image.

Magnification has a 'useful value,' namely that corresponding to the maximum resolution. Any more increase in the value of magnification beyond the limit of resolution is 'empty magnification;' since such an increase does not disclose any additional detail; on the contrary, the image becomes coarser or more fuzzy as such an increase entails the risk of introducing into the image purely optical diffraction and interference phenomena which, though inseparable from the image, are entirely foreign to the object. This effective value of magnification lies between the lower limit of 500 and the upper limit of 1,000 times the value of the numerical aperture.

The possibility of increasing the resolving power lies in using light of very short wave-length

as well as increasing the numerical aperture by embedding the object in a medium of very high refractive index. By using monobromide of napthaline as immersion and embedding medium, the value of the numerical aperture has been extended to the limit 1.65. In addition, by using light of short wave-length such as blue violet, the limit of resolution has been brought down to $2 \cdot 10^{-5}$ cm.

Photomicroscope

The possibility of lowering the limit of resolution by using ultra-violet light has also been well tried. The image, however, being no longer a visual one, is photographed and the optical system is made of materials, such as quartz, fluorite, which are transparent to ultra-violet light. Ultra-violet light can, however, produce a visual image indicative of structure, by exciting fluorescence in certain animal tissues and other substances.

The limit of resolution in the photomicroscope has been brought down to 1.5×10^{-5} cm; so the increase in the resolving power, in this way, is not very great.

The visual microscope exhibits cells, tissue fibres, as well as large microbes. But photomicrographs with ultra-violet light, record the presence of small microbes (*viz.*, small bacteria) as well as large viruses.

Ultramicroscopy

The ultramicroscope of R. Zsigmondy marks an advance over the compound microscope inasmuch as it rendered still smaller objects visible, although it does not enable us to see greater detail in an object than the latter. The ultramicroscope reveals the heterogeneity by means of the scattering of light. The material particles reveal themselves much in the same way as the particles of dust which may be seen floating about in a beam of sun-light passing through dusty air.

The bright-field observation in transmitted light, adopted in ordinary microscopy, is now replaced by the method of dark field observation, which consists in illuminating the object in such a way that only the light scattered by the object finds access to the microscope, no entry being allowed to the direct light. Stains are used to make the object particles luminous and consequently visible.

Ultramicroscopy has brought colloidal chemistry to the forefront, has done a good deal towards the development of the kinetic theory of liquids and gases by visualizing the Brownian movement and has rendered good service for the development of a number of physical problems.

The ultramicroscope reveals submicrons (so called by Zsigmondy) *i.e.*, particles of size 10^{-5} cm. to 5×10^{-7} cm. Amicrons, *i.e.*, particles of size 10^{-7} cm., though invisible by themselves, act sometimes as nuclei for condensation or deposition and are hence rendered visible.

Supermicroscope

A moving electron has a wave aspect and the length of the associated de Broglie wave depends inversely on the velocity of the electron. In fact, by increasing the velocity of the electron, the length of the wave can be rendered as small as desired. Hitherto, the value of the wave-length for fast electrons has been found to be 10^{-8} cm. to 10^{-9} cm. or even less, such a value corresponding to the X ray region. If such a wave could be utilised in microscopy, the aperture could be exceedingly diminished without any harmful increase in the concomitant spreading of the image points. Besides, the resolving power should also be exceedingly high, the spherical aberration being, at the same time, avoided due to the use of small aperture.

This has been the basis of the Super or Electron Microscope. The source of radiation is a beam of electrons from cold cathode or hot-cathode discharge. The focussing system, however, can no longer be any material lenses. In 1926, H. Busch showed that axially symmetrical magnetic and electric fields have the power of focussing cathode rays, much in the same way as light is focussed by an ordinary lens. The adjacent scheme attempts to explain the principle of the magnetic focussing. Depending on

SCHEME OF 'MAGNETIC LENS.'

H. Busch has shown that imposing no conditions on the magnetic field save axial symmetry, a pencil of electrons emanating from a point P can be brought to a focus at another axial point Q, provided the pencil is sufficiently narrow.

The actual paths are as indicated here:

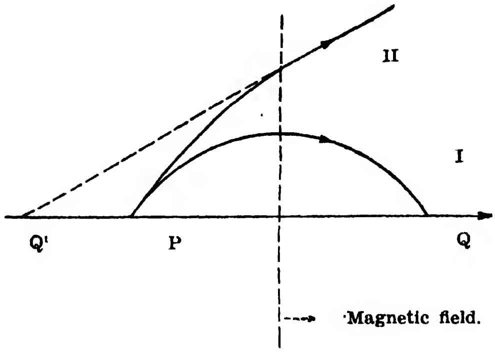


Fig. I.

Path I, of electrons, indicates convergence with formation of real image at Q; and path II indicates divergence from a virtual image at Q'.' The distance between the object and image points, *i.e.*, the distance PQ has been evaluated with an accuracy of some thousandths per cent.

IMAGE FORMATION WITH AN ELECTRON PENCIL.

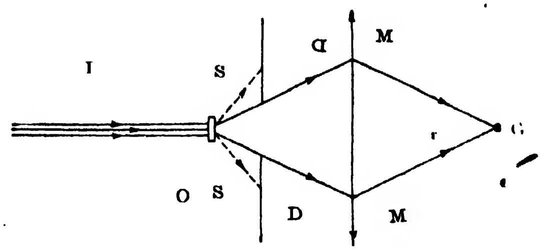


Fig. 2.

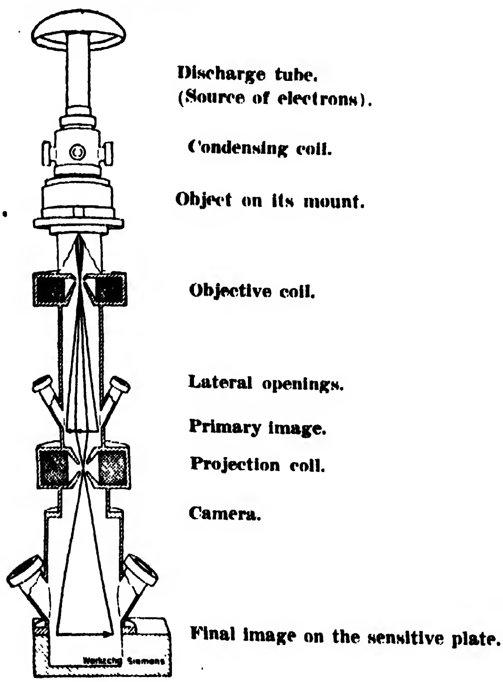
I- Fine electron pencil incident on the object.

O--Object on its mount. DD—Diaphragm.

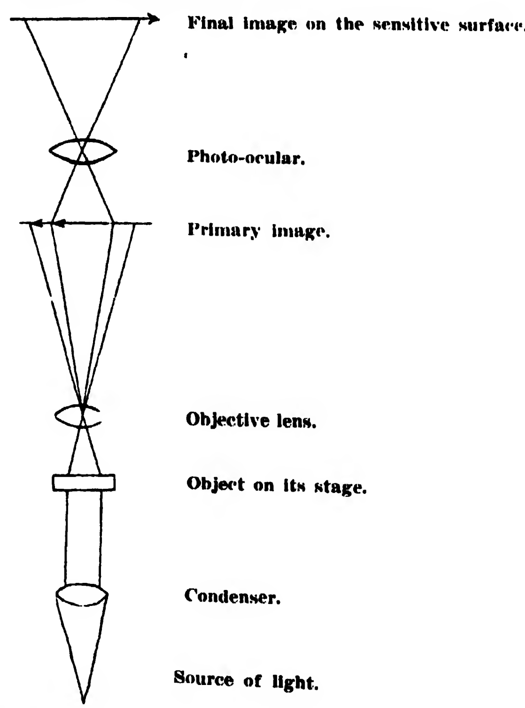
S, S —Scattered electrons. MM--Magnetic lens.

G--Image.

Electron Microscope.



Optical Photomicroscope.



The diagram shows the two arrangements, which bear good similarity in situation excepting the fact that the glass lenses of the optical system are replaced by 'magnetic lenses' in the electron-optical system and that one arrangement is topsy-turvy as compared to the other.

this property, 'magnetic lenses' *i.e.*, magnetic fields produced by current-carrying coils, *e.g.*, solenoids, are used for the new arrangement in place of ordinary lenses, the electromagnetic lens in this case being more convenient than the electrostatic one owing to high value of the accelerating potential. A fine axial beam of electrons is transmitted in succession through a number of iron-clad coils which represents successively the condenser, the objective and the projection eye-piece of a microscope and is finally received upon a fluorescent screen or photographic plate for registration of the image. The focal length of the 'magnetic lenses' can be altered by varying the coil current and hence the electron-optical image is well adjusted in sharpness. In the ordinary microscopic arrangement, the source of radiation is, as a rule, at the bottom and the ocular at the top; but in the electron microscope, the cathode or the source of electrons is over head and the sensitive surface is at the extreme bottom and the arrangement is thus an inverted one, compared to the former.

The electron beam, after emergence from the condenser coil, illuminates the object; for exact focussing the condenser can be shifted to all sides. The primary real image formed by the objective is received on an intermediate screen, an opening in which allows a part of the image to move on its way farther downwards, to be ultimately received on the sensitive surface in magnification after emergence from the projection coil. Lateral openings in the enclosing tube allow a view of the intermediate image which shows the whole preparation in minor magnification and then, also, of the final image which discloses the details in high magnification. The object, either in whole or in part, can be focussed properly by moving it sideways or in the direction of the axis. For the sake of comparative view and study, a photomicroscope can be set up in such a manner that the two microscopes can be exchanged without disturbing the object in its well-focussed position.

For the very reason that electron-beams are used, the whole apparatus must be kept evacuated. Methods have been devised so that both the object and the camera can be inserted and exchanged without disturbing the vacuum.

After the pioneering work of Knoll and Ruska in 1932, the field has also been explored by L. Marton in Brusseles, by L. C. Martin in Great Britain and notably by B. Von Borries, E. Ruska and H. Ruska in collaboration.

The first pictures obtained with these electron-optical arrangements were silhouette images, *i.e.*, outline pictures, of fibres, perforated metal foils and the like.

It has been possible to make the 'magnetic lenses' work at numerical apertures of much less than 0.1. Yet much improvement has to be made towards avoiding 'chromatic aberration' due to the presence of electrons with differing velocities, errors owing to faulty focussing, and the characteristic aberrations of extra-axial image points. Already, the best of the electron optical images have shown a resolution limit of about 0.01 μ or 1×10^{-6} cm., along with a very high magnification of as much as 30,000, the sharpness of the image being not apparently impaired thereby.

It may be thought that in photomicroscopy, if extreme ultra violet light of length towards 10^{-6} cm. could be used then its own resolution limit might be brought much below 1.5×10^{-5} cm., the value hitherto obtained. But insurmountable difficulties stand in the way. Moreover, such a high magnification in one step as already claimed by the supermicroscope, seems to be far beyond the reach of ordinary microscopy (with limit attained 2000) or photomicroscopy (with present limit 6000). Very important considerations centre round the mode of mounting and the process of illumination in supermicroscopy. Bacteria have been mounted on very thin films of nitro-cellulose as well as of collodion. Photographs of colloidal gold in a film of lithium borate have also been obtained.

In microscopic vision, objects are recognised either by contrasts of brightness or by contrasts of colour or by both. For contrast of brightness, there

must be a difference of refractive index between the object and its surroundings. Difference in refractive index gives what may be termed an 'outline picture' and so also difference in colour gives a 'colour picture'.

In supermicroscope as well as in photomicroscope the image being invisible, tiny objects have to be recognised by contrasts of brightness in the photographic record.

In electronic illumination, both elastic as well as inelastic collisions come into consideration along with the consequent scattering and change of energy of the incident electron. Evidently, the amount of scatterig by the object will be greater than that by the mounting film and thus widely scattered electrons failing to enter the aperture of the objective, may produce dark regions in the image and thus give rise to contrasts of brightness. Again the velocity-spread caused by the mount may interfere to some extent with the definition of the image which will then differ to some degree from purely silhouette effects.

"Thus the probabliity of detecting an object or separating the images of two objects, depends on the relative scattering power as distinct from the support, if any." (Prof. L. C. Martin).

Elimination of aberrations, e.g., spherical, chromatic as well as as coma, stands as another important factor. It does not seem feasible to obtain achromatic 'electron lenses' and so, alternatively, achromatism is to be sought in an incident beam as homogeneous in velocity as possible. Further, potentials as high as 75 kilovolts have been employed and various factors require a voltage of 50,000 or more; so steadiness in maintenance becomes a problem.

Lack of symmetry, as in ordinary microscopy, is here also to be sufficiently improved upon. But difficulties at once arise from the fact that the present microscope is given a length of about two metres to allow the attainment of the high magnification in two stages and that a complicated object-holder chamber along with adjustable coils has to be used. The magnetic field of the earth has also to be dealt with.

From considerations of prospective maximum perfection, Scherzer and Rebesch opine that "the limit of resolving power of electron optical systems will always be set at about ten to one hundred times the electron wavelength, instead of going below the wave length itself as might be inferred from Abbe's optical formula" Whatever the resolution may be, the high power feats of the super microscope are openly admitted and have been received with curiosity as well as interest.

Apart from all these, the electron microscope has a bearing upon the methods of analysis by 'X-ray' as well as 'electron diffraction.' The latter illummatingly reveal the atomic pattern, where some degree of regularity exists, by means of diffraction spectra, just as a diffraction spectrum presented by an optical microscope may prove the existence of a structure which, however, cannot be resolved by it. But the electron microscope seems to promise to expose irregularities and discontinuities in structures, even though it cannot deal with elements so small as those of crystal lattices.

Long before, the ultramicroscope displayed the kinetic behaviou. of molecules by showing the Brownian movement phenomenon. The supermicroscope has already exposed the inner structure of bacteria, small viruses, small colloids and also giant molecules, up to the size of 10^{-6} cm. The next forward step is to bring into visibility particles of size 10^{-7} cm., such as albumin, organic molecules and the like.

The supermicroscope is now in its first stage of development though its achievements have already been splendid. If the parts be so improved as to take in the central as well as the first electron diffraction maximum from a crystalline structure, the very elements of the lattice would be resolved in the picture according to Abbe principle. However, the prospect of resolution and the consequent vision of the atom is yet a speculation.

View into the Invisible Realm

Range of dimensions covered by different devices

Visual appliance.	*Resolution limits reached.* 10^{-2} cm.	10^{-3} cm.	10^{-4} cm.	10^{-5} cm.	10^{-6} cm.	10^{-7} cm. & beyond.
Bare Normal-Eye.	(*a*) Fine fibres. (*b*) Thin blades.					
Simple Magnifier. 1000 A.D.	. . . .	Tissue structures				
Compound Microscope. 1650 A.D.	. . . .	. . . .	(*a*) Cells. (*b*) Bacteria. (*c*) Particles in ordinary suspensions.			
Photo-Microscope. 1905.				(*a*) Small bacteria. (*b*) Large viruses.		
Ultra-Microscope. 1905-1910.					Colloidal particles. (Mere vision, and no resolution).	
Super-Microscope. 1938.				(*a*) Inner structure of bacteria. (*b*) Large colloids. (*c*) Viruses.	(*a*) Small colloids. (*b*) Giant molecules.	
Further improvement of Super-Microscope.						(*a*) Albumin. (*b*) Organic molecules & beyond.

The chart gives a comparative view of the limits of resolution attained by means of different devices along with the approximate dates of their origination.

NOTES AND NEWS

OBITUARY

Dayaram Sahni

In the death of Rai Bahadur Dayaram Sahni, late Director General of Archaeology in India, the country has lost a most distinguished scholar and archaeologist. Dayaram Sahni was educated in the Punjab University where he topped the list in the M. A. Examination. For a short time he served as a lecturer in that university and was then appointed Government of India Scholar for training in archaeology. In 1910 he entered Government Service as assistant superintendent, Archaeological Survey. He successively held the posts of curator of the provincial museum at Lucknow, superintendent of Archaeology in Kashmir, superintendent of the Archaeological Survey of India, and Deputy Director-General of Archaeology. In 1931 he was appointed Director-General of Archaeology and was the first Indian to hold that exalted position. His name will always be associated with many important discoveries and excavations of ancient sites in India including Harappa, Mohenjo-daro and Sarnath. His discoveries and the work of the late R. D. Banerji pushed the antiquity of Indian culture and civilisation back to 4000 B.C. After retirement Rai Bahadur Sahni joined the archaeological department of Jaipur State as the director, and the important excavations carried out there have put Jaipur on the archaeological map of India. He had numerous publications to his credit and wrote two chapters for Sir John Marshall's monumental work, *Mohenjo-daro and the Indus Valley Civilisation.*

William Ramsay

A Reuter message from London announces the death of Sir William Ramsay, the famous Scottish archaeologist at the age of 88. William Mitchell Ramsay was born at Glasgow and educated at Aberdeen, Oxford and Gottingen Universities. He became a Fellow of Exeter and Lincoln Colleges, Oxford and in 1885 was elected professor of classical art there. Next year, however, he went to Aberdeen as professor of humanity (Latin). In 1911 he resigned his professorship and continued the research and literary work which had been his chief occupations.

In 1880 he began his travels in Asia Minor which occupied his leisure for many years and made him a recognised authority on Christianity in the early Roman Empire and in the regions in which St. Paul travelled. His researches were facilitated by the fact that in those days there was no summer term at Aberdeen University. He made at Antioch in 1914 the most remarkable find in three centuries. While digging at the edge of the forum he came on fragments two feet from the surface of inscriptions by the Roman Emperor Augustus describing his exploits. Ramsay was able to reconstruct and translate what is known as " the greatest inscription in the world.

His valuable work was recognised by the conferment of the honorary degrees of D. C. L. by Oxford, LL.D. by St. Andrews and Glasgow and the D.D. by Edinburgh. In 1906 he was knighted. A member of many learned societies in Europe and America, he was awarded medals by the Royal Geographical Society and by the University of Pennsylvania.

His publications include *The Historical Geography of Asia Minor, The Church in the Roman Empire, The Cities and Bishoprics of Phrygia, St. Paul the Traveller and the Roman Citizen, Impressions of Bethlehem, The Education of Christ, Lucan and Pauline Studies, The Making of a University* and *The Life and Letters of William Black.*

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New Egyptian Royal Tomb in the Nile Delta

The Times of March 20, announces an important archaeological discovery in the ancient city of Tanis in the Nile Delta. Professor Montet of Strasbourg, who has been engaged for some years in excavating the site, has discovered the first gold coffin to be found in Egypt since that of Tutankhamen and also a silver sarcophagus. The present find was made in excavating a series of funerary chambers of the tombs of kings of twenty-first and twenty-second dynasties (1110-950 B.C.) regrading whose residence no certain knowledge was hitherto available. The funerary chambers were empty, but a narrow corridor was found leading to a wall which when pierced led to a chamber built of white limestone and containing a gold sarcophagus inscriptions showing that it was of king Shishak who is mentioned in the Bible. Two human skeletons still wearing ornaments were found on either side of the sarcophagus and there were many jewels among the remains. Another chamber has also been discovered and opened. It is possible that this may be the first of a whole series of royal burials belonging to the twenty-first and twenty-second dynasties. The walls of both the chambers discovered and since opened are covered with paintings and inscriptions, strikingly absent from the tomb of Tutankhamen. Many historical data may presumably be recovered from these inscriptions.

Deterioration of the River Hooghly

A tendency of silting in the river Hooghly has been noticed for a long time. The situation has become rather serious as a result of heavy silting near the intake of Calcutta Corporation's pumping station at Mullickghat for the supply of unfiltered water in the city. It is apprehended that unless adequate preventive steps are immediately taken there will be difficulty in the supply of water to Calcutta in the near future.

This continuous heavy silting may also threaten the future of Calcutta as the premier port of India. Even now occasions arise when ships are unable to leave the port on the stipulated day owing to insufficient depth of water and their journey to the open sea has to be made in 'hops', going down a few miles on each full tide. A stage seems to have reached when dredging alone could not possibly combat against the natural agencies always at work to fill up the dredged profile of the foreshore. This deterioration of the river was noticed nearly two decades back when it was observed that the bed levels of all the rivers constituting the headwaters of the Hooghly had risen gradually during the last century. It is unfortunate that no action was taken in these two decades to improve the condition of the Hooghly or its feeder rivers except periodical dredging. It has been pointed out that the emergence of bars in the upper reaches of the Hooghly indicates a weakness of natural scouring of the river bed and unless these are scoured away by restoration of the old time freshets the Hooghly as a river is bound to decay. The chief engineer of the Calcutta Corporation will visit the U. S. A. shortly and get into touch with the river engineers there, responsible for the training of the Mississippi and other connected rivers. Is it not a pity that when the problem has become so menacing, our engineers and specialists have to go over to the other end of the globe just to learn actually what is being done there under similar circumstances? In our columns, and in several articles published (*vide* SCIENCE AND CULTURE, *1, pp.* 5, 165, 219, 1935) we have more than once drawn the attention of the authorities concerned to the acute and important problem of training of the rivers and opening of River Physics Laboratories in the province where scientific examination of all relevant historical and hydrographical data may be undertaken. From some recent utterances of the Minister in charge of the department of Irrigation and Communication of the Government of Bengal, it appears that the Government has ultimately realised the seriousness of the situation and is contemplating the establishment of River Physics laboratories and exploring other ways and means of tackling the problem. But in Bengal this problem of dead and decaying rivers is so vital and intimately connected with the wealth and welfare of its people that the Governmental authorities should give up their proverbial dilatoriness and make some real definite move in the right direction.

The 1941 Census

The census in a country where the population exceeds 350 millions is undoubtedly a huge undertaking and naturally the Government of India has already begun preliminary preparations for the next census in 1941. Much more information has to be gathered than mere counting of the heads so that the data collected may serve as mines of information to statisticians, administrators and scientists and also supply valuable sociological and ethnological material. The Govern-

ment of India has requested the provincial governments to furnish their views regarding the nature of information to be collected at the census. The census commissioner has suggested that information relating to 'caste' and 'infirmities' which were hitherto included may be omitted at the next census. Tabulation of statistics of caste entails considerable volume of work and cost and practical difficulties are encountered everytime regarding this particular item of the census. On grounds of general principle also tabulation of caste may be done away with. As for the other item *viz.*, the table of infirmities which the Government proposes to omit, it has been pointed out that during previous census such tables were so defective as to be of little statistical value. Medical statistics are really a very important branch of census work. At present in India lack of such information stands in the way of correct appreciation of the situation. As for example investigations of the trend of population growth in the country is not at all easy owing to defective statistics relating to fertility of women. Similar instances can be multiplied and until such relevant data are available it will be hardly possible for the nation to tackle the vital problems of human welfare. But probably collection of such statistics can not be entrusted to enumerators engaged in ordinary census work and has to be undertaken by experts. However, the Government can not indefinitely remain inactive in a matter of such urgent necessity and importance and should do whatever is possible for collection of such useful medical statistics.

National Nutrition Policies

A recent publication of the League of Nations (*Survey of National Nutrition Policies, 1937-38*, Geneva: League of Nations) gives a brief review of the nutrition survey work undertaken on an international basis following the recommendation of the League's Mixed Committee on Nutrition. Faulty diet is the direct cause of a heavy mortality and a great deal of ill-health throughout the world. With a view to combat and prevent diseases due to faulty diet twenty-one countries have set up national nutritional committees to collect information regarding the state of nutrition in their respective countries, to make a survey of the extent of the damage done due to malnutrition and to ascertain what is needed to make national diets fully adequate for health. Enquiries are conducted on what foods and what amounts are consumed by different classes of people. Family budget enquiries and dietary survey will enable estimates to be made of nutritive value of diet of different classes and income necessary for adequate nutrition, and the extent to which ill health can be attributed to dietary deficiencies. The committee has recommended another line of enquiry *viz.*, a survey of total national food supplies—home products plus imports, and a comparison of total food available with total national nutritional requirements. This information will show what changes are needed in national food policies.

The work of most of these national committees is still in the initial stage but the information brought out even now shows the great need for a worldwide investigation and the immense possibilities of promoting human welfare by the application of 'the newer knowledge of nutrition'. In respect of heavy mortality and ill-health, India compares very badly with most other countries of the world, no observation worth the name has been made in this country of the standard of nutrition in different parts and among different classes. However, in India it is more a solution of the question of starvation than proper nutrition which probably needs our immediate attention. The work of these national nutrition committees dealing with this urgent worldwide problem, shows the direction in which modern science can most easily be applied for the promotion of human welfare. It lies with the Government however to devise ways and means for increase of production of adequate foods, to look after their proper distributions and adjust the economic system in such a way as to bring adequate diet within the reach of all and to carry out educational propaganda so that families may adjust their expenditure on food to the best advantage.

Nationality and Race

In an interesting lecture delivered at the Calcutta Rotary Club, Dr B. S. Guha discussed how far the racial policy adopted in some of the Western countries based on a conception of racial purity and racial superiority has any meaning when examined in the light of biological foundations on which it ought to be based. 'Race' originally was used to denote different somatic divisions of man but later it has been somewhat confused with linguistic and cultural divisions as well. In a strictly biological sense man belongs to one species alone, *viz.*

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Homo sapiens and the broad divisions of mankind do not show mutual sterility when intercrossed as happens between locally differentiated types of animals. This is a consequence of the fact that man has wandered about the world from the earliest times and a process of through mixing up between various human groups has taken place. In the human populations found nowadays in all countries the somatic types are the results of recombinations of various *genes* (discrete living particles of matter which determine our hereditary constitution) derived from several original sources. It is not possible to think of a biologically pure race among existing human groups and it is also impossible to trace any of these types to a preconceived ancestry. A nation on the other hand, as constituted today, is a mere social concept and need not imply a community of racial type or language. Racial diversity may however prove to be a disruptive force and the fear of it has given rise to the ideal of racially homogeneous nation as manifested in the immigration laws of some countries and the Nazi theory of a Germanic nation. Behind this there is also the idea of racial superiority *e.g.*, the Nordic doctrine of embodiment of all virtues in the tall, blond, dolichocephalic man of Northern Europe. Dr Guha exploded the theory of racial superiority and pointed out that advances of civilization were not due exclusively or primarily to the Nordics or other white races of the West, but in fact many important factors in our civilization such as agriculture, pottery or the art of writing originated among non-Nordic peoples of Asia. Even today the differences between racial types are to a large extent due to different social environments and not solely to 'innate mental qualities.' The virtues claimed for a particular race are almost always created for self interest and wish fulfilment and are due to artificially bolstered up racial prejudice. Dr Guha cited certain facts revealed in the criminal survey of the U. S. A. undertaken by the Harvard University which disclosed, contrary to preconceived notions, that the Nordics who claim a monopoly of truthfulness, courage, sense of justice and fairplay, showed the largest percentage of offences of fraud and forgery, while the 'dirty' Negroes showed the lowest percentage of rape and sex offences. Dr Guha's conclusion is that there is no instinctive racial antipathy in man and racial prejudices are artificial and can be removed by the removal of differential barriers and the creation of a congenial atmosphere.

The New Cyclotron at Berkeley and Recent Developments in Cyclotron Technique

The cyclotron, though only a recent product of the imagination and experimental skill of Prof. Ernest Lawrence of California, has proved to be the most valuable tool in the hands of experimental physicists in unravelling the mysteries of the atomic nucleus. Much more interest and importance have recently been attached to it owing to its application in medical and biological research and its use for therapeutic purposes. At Berkeley, California, the first cyclotron to be built for the purpose of medical and biological research is almost completed. In the preparation of radioactive substances for therapeutic or for 'indicator' purposes, large yields are always essential and this can be achieved either by increasing the current or the energy of the emerging beam of particles from the cyclotron. In the new Berkeley cyclotron it is hoped to obtain deuterons with energies in the neighbourhood of 15 million electron volts whereas the energies of the deuterons in the present cyclotron working at Berkeley is within the range of 6 to 9 million electron volts. A technique has also been developed by which the current-strength of high-energy ions in the cyclotron can be considerably increased, thus ensuring much greater yield of radioactive products. In the new arrangement the material to be bombarded in spite of being placed in a separate chamber as was done previously, is mounted on a water cooled plate and then inserted between the 'dees' through the window of the cyclotron. As a result the effective strength of the ion current utilised for bombardment is increased many times. Using this technique they have succeeded in obtaining 10 millicuries of radioactive phosphorous in the course of a day.

Prof. Lawrence in collaboration with his brother Dr John Lawrence has for sometime past investigated the possibilities of using neutron irradiation for treatment of cancer. Experiments carried out on mice, using transplanted sarcoma tumours, indicated that neutrons were 20-30 per cent more efficacious than X-rays in destroying malignant cells. The new cyclotron at Berkeley has been designed for these experiments to be carried out on a clinical scale. For the experiments to be successfully carried out, it is necessary that a collimated beam of fast neutrons should be directed upon the locality to be irradiated and this has been successfully done by passing the fast neutron beam from the cyclotron through a narrow air channel in a water tank, the depth

of water in the tank being sufficient to appreciably absorb or reduce the velocity of all the neutrons except those passing through the air channel. To eliminate the gamma-radiation originating in the source and the water tank, the beam of fast neutrons was filtered through a slab of lead and the tank also was covered outside with the same material. With the above arrangement clinical treatment has already begun in Berkeley. In arguing for the merit of the cyclotron for medical purposes it would be engugh to point out that already sources of radioactive sodium have been prepared in Berkeley with a strength of several hundred millicuries using the older technique of bombardment with deuterons in the target chamber. Radioactive sodium in the process of decay emits gamma ray of such energy that it may displace radium for many purposes. Remembering that the yield of radioactive sodium can be largely increased by using internal target method and also taking into considerations the possibilities of neutron irradiation on malignant tissue, the expenditure on the construction of cyclotron for medical purposes would be justified.

There are now more than twenty-five cyclotrons, either operating or under construction, in various parts of the world. In India where scientists have to work under conditions of extreme financial stringency, it has not been found possible to undertake the construction of a single cyclotron mainly due to paucity of funds. Now that the immenses possibilities and uses of the cyclotron for medical purposes have been amply demonstrated, there is no reason why the medical department of the Government should not come forward with adequate funds and undertake the construction of a cyclotron in co-operation and collaboration with some of our eminent physicists.

Historic Finds in Bihar

The first definite stone image of the Maurya period yet discovered, terracotta figures dating from 300 B.C., bronze images of the Pala period, a Persian manuscript copy of the *Shah Nama*, specimens of Persian calligraphy and Moghul and Rajput paintings, are some of the outstanding treasures added to the collections of the Patna Museum, according to the latest report issued for 1935-38. In the Archaelogical Section no fewer than 1,943 valuable additions and acquisitions were made. Two stone torsos, probably of Jaina images of Tirthankaras, were unearthed in February, 1937, in Lohanipur village, in Patna. The larger of the two images bears "Maurya" polish and is the oldest Jaina image yet found in India. To discover the heads and limbs of the two images a search was made and the site was excavated by the Treasure Trove Officer. The site yielded many broken pieces of Maurya style and the foundation of a structure measuring 8′ 10″×8′−10″. A number of valuable coins and terracottas discovered during sewerage operations in Patna city have been added to the Museum collection. Numismatics and art account for 3,438 and 128 specimens respectively. Of the art sppecimens, the Persian manuscript copy of *Shah Nama* illustrated in two volumes, transcribed in 1599 A.D. is a notable addition. In the miscellaneous section the important additions are a manuscript copy of *Pragyanparamita* in Tibetan characters, written in gold lettering. It is about 500 to 600 years old. There is also an illustrated manuscript copy of Yusuf Zullekha written in Persian "Nastaliq" character, containing eleven pictures of the Moghul school of the early 19th century.

Rumblings of Earthquakes

Investigations of the fearful rumblings which accompanied the disastrous Nepal-Bihar Earthquake of 1934 have been completed by the Geological Survey of India. Observers agree that the Bihar earthquake was preceded and accompanied by sound, variously described as comparable with the noise of " several aeroplanes ", " a heavy motor lorry ", " an approaching goods train ", " a passing motor car ", or " a train passing through a tunnel ". In the central regions several observers recorded that the sound appeared to emanate from the ground beneath their feet. The sound was loudest in North Bihar, Sitamarhi-Madhubani area, Nepal Valley, Patna and Monghyr, and drowned the noise caused by the falling buildings and the rattling doors, windows, furniture and the like. The sound was recorded from places as far away as Cuttack on the Mahanadi delta, and the Godavari-Kistna delta. During some of the after-shocks similar sounds were heard locally. Difficulty has sometimes been felt in explaining shocks that are said to be heard before they are felt, for seismic waves travel faster than sound waves. However, the sounds emitted are independent of the speed of the seismic waves, but are indirectly dependent upon their frequency. During the transmission of seismic waves, rock particles are moving rapidly against each other and the secondary vibrations so set up may give rise to sound waves. Sounds have also been recorded as arriving

several minutes after earthquake shocks. These are usually heavy reverberations and come from a definite direction, commonly that of the epicentre. Sounds of this nature were not heard after the Bihar shock. Even if they had occurred it is doubtful whether they would have been noticed in the excitement that followed. In the areas north of the Ganges, there was a general consensus of opinion that the sound passed from a north westerly to a southeasterly direction. It is difficult to judge whether or not this consistently described direction was a psychological effect arising from the early acceptance of the epicentre as being in the Himalayan foothills. So far as can be judged, the sound was heard more or less simultaneously over the whole area and could not accordingly have originated from a point. It is suspected that the consistently reported direction of movement of the sound may be psychologically connected roughly with the felt direction of movement.

Entomological Research at Dehra Dun

Modern research on insect pests is dependent on systematic entomology to a very large extent. During the last year along over two and a quarter lakhs of specimens of insects have been named by the Entomological Branch at the Forest Research Institute at Dehra Dun. This enormous total includes 83,500 specimens derived from insectaries maintained for the study of shisham defoliators in the Punjab, 67,400 specimens from the insectary and experimental plots dealing with teak and mahogany pests in Madras, 14,300 sandal insects examined for the investigation of spike disease, 19,000 specimens bred in the Dehra Dun insectary out of material originating from all provinces and 22,800 specimens obtained from a survey of the insects frequenting lantana. This means about 860 identifications per working day throughout the year and the work occupied the whole time of several entomologists.

Studies confined to any one pest and that pest alone cannot produce silvicultural and ecological control measures. To discover methods which will be effective without the necessity of direct remedial action on the part of the forest officer it is essential to study many interdependent life-communities in the forest and the pest is only one unit in this complex. Moreover, reliable conclusions cannot be drawn from scanty observations but must be based on adequate statistical data. This explains why so much labour is necessary in order to devise a remedy for any insect pest.

Air-breathing Fish

An exhibition of the air-breathing fish of India has been made in the newly arranged Fish Gallery of the Indian Museum recently installed by the Zoological Survey of India. The various structures responsible for aerial respiration in five types of fish are shown by dissected models, and the origin of the air-breathing habit and the structures responsible for breathing air are briefly described. Generally speaking all living matter, whether of plant or animal orgin, requires air or, to be more exact, the oxygen contained in it for respiration. Land animals take the air directly from the atmosphere, while aquatic animals use the air that is held in solution in the water in which they live. Fish, as is well-known, belong to the second category, but a few species found living in the fresh waters of the tropical parts of the globe, while retaining gills for 'breathing' in water, have become specially adapted for aerial respiration. Of the types of fish exhibited in the Gallery, the well-known *Koi* fish of Bengal (*Anabas*), possesses two special chambers developed above the gills for the storage of air; each chamber contains a labyrinthiform organ, composed of shelf-like plates, the skin of which is richly supplied with fine blood vessels. This organ acts as the "lung" of the fish. In various species of the snake-headed fish *Sol, Sauli, Lata, etc.,* (*Ophicophalus*), the accessory respiratory organs are of the nature of two lung like reservoirs in the head, developed as pouch like outgrowths from the mouth cavity. The inner linings of these cavities are richly supplied with blood vessels. In *Magur* (*Clarias*) there is an air-chamber above the gills into which three like outgrowths project from the upper ends of the gill-arches. These outgrowths are richely supplied with blood vessels. In *Singi* (*Heteropneustes*) two long tubular sacs grow from the gill cavities backwards among the muscles of the back; they bear a marked resemblance to the lungs of land vertebrates. In *Cuchia* (*Amphipnous*) the accessory respiratory organs consist of two lung-like chambers. This fish with its gills greatly reduced has practically lost all power of aquatic respiration. The great variety of structural devices evolved for aerial respiration in fish in response to stagnation and drought shows the remarkable power of adaptation possessed by animals

in general to changing conditions of life. It is the acquisition of such adaptations that enables the animals to survive in the very keen struggle for existence which all of them have to face in nature.

Announcements

For the first time in the history of Cambridge University a woman, Miss Dorothy Annie Garrod, has been appointed to a professorship. Appointed to succeed Prof. E. H. Minns in the Disney professorship of archaeology, one of Cambridge's oldest professorships, Miss Garrod has made unique archaeological discoveries, the most important of which was in the Balkans in September last year when she found 50,000-year old caves, which yielded data for linking the cavemen of the Balkans with those of Palestine and the East.

At the meeting of the Royal Society, held on March 16, the following were elected fellows of the Society: G. S. Adair, assistant director of research in physiology, Cambridge; C. H. Andrews, pathologist, National Institute for Medical Research; M. Born, Tait professor of natural philosophy, University of Edinburgh; A. J. Bradley, asst. director of research in crystallography, Cavendish Laboratory, Cambridge; D. Brunt, professor of meteorology, Imperial College, London; F. A. E. Crew, Buchanan professor of animal genetics, University of Edinburgh; F. W. Edwards, Department of Entomology, British Museum; B. M. Jones, Mond professor of aeronautical engineering, Cambridge; G. W. C. Kaye, superintendent, physics department, National Physical Laboratory; E. G. T. Liddell, fellow of Trinity College, Oxford; E. J. Maskell, lecturer in plant physiology, Cambridge; I. Masson, vice-chancellor of the University of Sheffield; formerly professor of chemistry, University of Durham; C. E. K. Mees, vice-president of the Eastman Kodak Company, Rochester, N. Y.; M. H. A. Newman, lecturer in mathematics, Cambridge; H. H. Read, professor of geology, Imperial College, London; Sir R. G. Stapledon, professor of agricultural botany and director of the Welsh Plant Breeding Station, Aberystwyth; H. M. Turnbull, Professor of morbid anatomy and director of the Bernhard Baron Institute of Pathology, London Hospital; E. E. Turner, head of the department of organic chemistry, Bedford College, London; V. B. Wigglesworth, reader in medical entomology, London School of Hygiene and Tropical Medicine; E. J. Williams, professor of physics, University of Wales, Aberystwyth.

Dr J. N. Bhar, assistant lecturer in the University College of Science, Calcutta, has been admitted to the degree of Doctorate of Science of the Calcutta University. Working under Prof. S. K. Mitra, he has made detailed studies regarding the ionosphere in this country and has made important contributions to our knowledge of the subject.

SCIENCE IN INDUSTRY

New Cotton Schemes

The Indian Central Cotton Committee has approved subject to examination of final details by the Standing Finance Sub-Committee, the recommendations of the Technological Research Sub-Committee for the purchase of a pilot plant for determining the cost of production of chemical cotton from linters, waste and cheap cotton. Sanction was also provisionally accorded to a scheme for carrying out investigations at the Technological Laboratory for improving the ginning of Indian cottons involving an estimated non recurring expenditure of Rs. 24,500 and a recurring charge of Rs. 4,600 per annum.

Work on Indian Forest Products

A wood from Madras (*casuarina equiseti-folia*) is being tested at the Forest Research Institute, Dehra Dun, to see whether it is suitable for telegraph and telephone lines and electric transmission work. Others, spruce and fir of the inner Himalayas, are being tested for aircraft construction and repair work. Experiments are being made on *Sal* to determine the variation in strength of the species in different localities. Further steps taken at the Institute to promote greater industrial use of the forest resources of India, include the preservative treatment of wood and cover a great many aspects of timber utilization from a study of the working qualities of different species to the testing of glues, almio boards and plywood. Recently it has been arranged for carrying out manufacturing and service trials on various Indian woods for shuttles, bobbins and other woodwork requirements of textile mills. A simple type of tunnel drier for drying veneers was designed at the Institute for a firm in Calicut, Madras, who are manufacturing commercial plywood. This was built and put into operation before the start of the monsoon last year and is now giving satisfactory service.

Experiments have shown that with the exception of *juniperus macropoda* which occurs in inaccessible parts of Baluchistan there is no other wood which is as good for pencil manufacture as imported pencil cedar.

Work in connection with the preparation of hand lens keys, supplemented with low power photomicrographs, for the identification of the more important timbers of Assam and Bengal, was continued by the wood technology section. The services of this section were utilized with advantage by railway officers, engineers, timber merchants, the army department, the forest department, jute mills and other firms.

Large number of botanical specimens continue to be received for identification by the botanical branch, and more than 2,800 specimens were incorporated in the herbarium during the year. The fungal diseases, which cause widespread unsoundness and mortality of *sal* trees in Bengal, Bihar and United Provinces are engaging the attention of the mycologist. A preliminary test of the toxicity of Asen and creosote has been carried out and further experiments on these preservatives are being continued.

Dozens of drugs and herbs were grown successfully in the minor forest product garden. Experiments were carried out on *vitex pendunculari*s which is a reputed remedy for black water fever, and an active constituent was isolated which is being examined pharmacologically. Investigation on fish poison plants, the object of which is to find out which plants contain rotenone and allied bodies and determine how far India can be a source of supply of vegetable insecticides of the types of denis, for which there is a demand

and a valuable trade was carried on. A list of Indian plants reputed as fish poison has been compiled.

The most important part of the year's work in the entomological branch, was the study of the parasites of defoliators of teak, *sissoo* and mulberry. An interesting feature of this work has been the successful transference of parasites from Burma to the teak plantations at Nilambur, the parasites being shipped in cold storage to Madras and thence by parcel rail to Nilambur. The entomologist completed a very thorough study of the bostrychid wood borers which are pests of sawmills and factories.

A research demonstration course has been instituted in the Institute, which it is hoped will be made an annual one. The first course was held in October 1937 and was attended by some 15 officers, representing nearly all the provinces.

Catalytic Cracking

A new catalytic cracking process for petroleum has been developed and large scale equipments are being installed in U. S. A. Cracking processes which have been in operation for years have been important, both in conserving crude oil and in improving the quality of the motor fuel. Without cracking processes, it would have required some two billion barrels more of crude oil to supply the world's needs in 1938 than were actually produced as is reported in *Industrial and Engineering Chemistry*.

Cracking by thermal processes involves the use of great heat applied while the oil is under high pressure. Catalysis on the other hand while most effective is a gentle force. In catalytic cracking the oil is vapourized and the vapour passes over the surface of a catalyst where the molecules are separated with a high degree of selectivity and at great speed. The thermal cracking process produces an oil of 70 to 75 per cent of gasoline having an octane rating of 72. The new catalytic cracking process produces 85 per cent of gasoline with an octane rating of 81 or higher. In fact the inventors expect producing gasoline of 100 octane rating by the new process without difficulty. It is possible that catalytic cracking will supplant entirely all the thermal cracking processes, though the transition will be gradual.

Sterilization of Water and Air by Ultra-Violet Rays

Chlorination, ozonisation and other chemical methods of water sterilization commonly used all have the disadvantage that they may alter the taste and chemical composition of water and need to be carefully steered between the two extremes incomplete sterilization and presence of excess of the sterilizer. Moreover, for some purposes the use of chlorinated water is not permissible. The use of ultra-violet rays for sterilization was not extensively used due to certain drawbacks inherent in the apparatus, which are somewhat cumbrous and fragile. The new ultra violet ray apparatus working on the new high pressure electronic discharge principle has made it possible to use this apparatus for big scale water-sterilization. It has been found by extensive bacteriological tests that pathological organism such as B. Coli, the typhoid bacillus, soil bacilli, etc., and other injurious organisms are destroyed even in heavy concentrations by the new apparatus designed by Hanovia Ltd.

It is found that in a modern operating room in spite of every reasonable precaution to ensure asepsis, excepting ultra violet, considerable numbers of bacteria may be collected from the air by sedimentation. In new apparatus, low pressure, filter-jacketed type of quartz discharge tubes are being used, for ultra-violet sterilization in hospitals which filter off all radiations shorter than 2200Å. The amount of ultra violet which may fall on the patient during the course of the operation should be kept sufficiently low so that no reactions will be caused on the tissues exposed. By the use of adequately designed ultra-violet installations in the air-ducts of air conditioning systems, cross infections in public buildings are being prevented.

Filtering Gas through Glass

The separation of dusts and other minute suspended particles from gases is of vast importance to industries. Many costly and elaborate processes such as gravity collectors, scrubbers, washers, electrostatic separators, etc., are in operation at present. But use of fabric filters though much less costly has not been favoured since they are of organic origin and in most cases cannot resist the chemical nature of the gases which are to be purified. Now glass fabrics have entered the field. Rapid progress in the development of satisfactory all-glass filter fabrics makes it probable that both gas and liquid filtration through this acid proof, heat-resisting, inorganic media will soon become

common. Glass filtering fabrics has already been put the market.

New Valves for Television Purposes

With the rapid development of television receivers, valve manufacturers are now confronted with new problems which are becoming increasingly difficult to solve. The pinch methods of construction hitherto employed in ordinary valves necessitates long leads connecting the electrodes to the contacts on the valve-base. This causes a capacitive and inductive coupling between the electrodes. In the case of valves in which very low capacity between certain electrodes is essential, as for instance with H. F. amplifier valves, one electrode is always connected to a contact on the base and the other (usually the control grid) to the metal cap on the bulb. But a top connection requires a long external lead and this entails great difficulty when receiving ultra short waves as used in television transmissions.

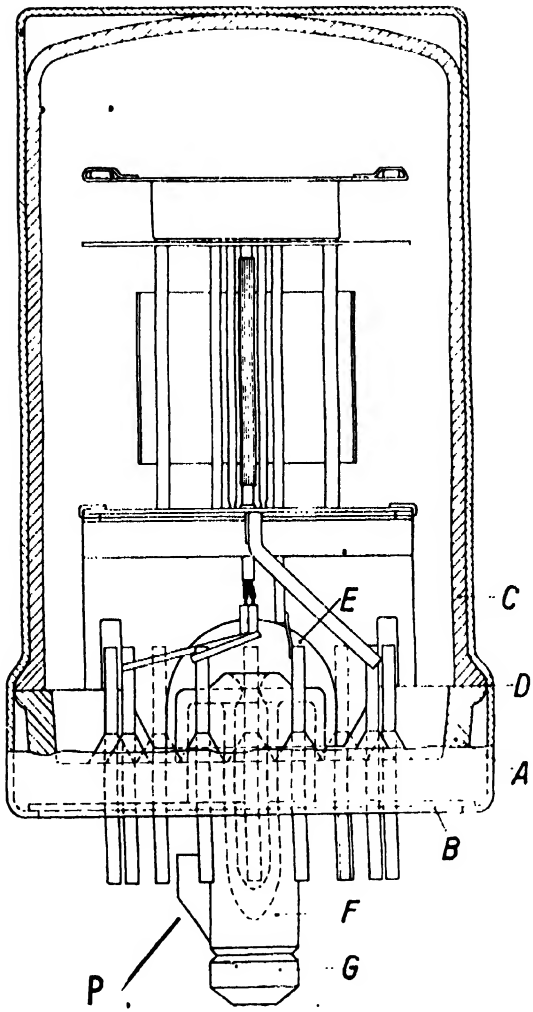

Fig. 1. Section of the new Philips valve in which the glass pinch and the bakelite base are replaced by a glass base.

A new form of valve in which all the electrodes are led out on one side, has recently been introduced by Philips. In these valves the pinch and neck are replaced by one single part, *viz*, a pressed-glass base (A in fig. 1) with 9 chrome-iron lead-out pins which also constitute the contact pins and supporting wires for the electrode unit. Chrome iron was selected because this material has the same coefficient of expansion as the type of glass used. The electrode system is mounted on the 9 pins. These pins are 1·1 mm. thick and are positioned uniformly around a circle measuring 21 mm. in diameter, thus giving very short leads and a sturdy construction. The glass bulb (C) is of such a shape that it can easily be machine-manufactured. It is sealed to the glass base at (D) (fig. 1). The glass base is fitted with a metal screening plate (B) which screens the pins from each other. This plate has a locating spigot (F) which facilitates the insertion of the valve in its socket. If the valve is of a type that requires to be screened against external influences, the bulb as well as the glass base is provided with a metal cover.

Besides effecting a reduction of the mutual electrode capacities the new construction has a number of other important advantages due to elimination of the bakelite base of ordinary valves. The lead out wires need no longer be soldered at the contacts or contact pins the number of welding points being reduced to a minimum. There is consequently less risk of loose contacts causing crackling noises, the suppression of which is an imperative necessity in the very complicated type of receiver used for television.

A further advantage of the new construction is that the troublesome phenomenon known as "frequency drift," which occurs during the first few minutes after a receiver is switched on, is practically negligible in these new valves. Bakelite, the material of present

type valve-bases, has a dielectric constant which varies considerably with temperature. As this base has been entirely discarded in the new valve, allowance need only be made for variation of the dielectric constant of glass, which is extremely small.

A new type of socket for this valve has been designed by applying the principle of the bayonet holder. By means of the locating spigot with its fixing stud, the valve is inevitably inserted in the right manner. Next, the valve must be slightly turned so that the contact pins snap into position between springs provided for the purpose. The fixing stud, which does not extend to the bottom of the valve, then comes under the pertinax disc of the socket and thus locks the valve in position so that it can not possibly be loosened from its socket by vibration when used under strenuous condition, as, for instances, in an aeroplane. The locking system also renders it possible to transport receivers from one place to another with the valves already in position without any risk of their being shaken out.

Engines Cooled by Glycol

The industrial applications of glycols and their derivatives are innumerable. A recent count indicated that there are 143 different applications for the glycols without considering their derivatives. In the decade since the first tank car of ethylene glycol was shipped, six different glycols and fifty glycol derivatives have been made commercially available. Seventeen have already reached a stage of industrial importance which require their shipment in tank car quantities. The number of amine, ester, ether, and other derivatives of glycols is increasing gradually.

Ethylene glycol is used as an antifreeze and inhibitor to corrosion in automobile cooling systems. Water containing the inhibitor is 95% less corrosive on iron and steel and 75% less on aluminium and other radiator metals than plain water. During the past ten years, a great deal of development work has been done on glycol cooled aircraft motors. In these, the ethylene glycol does not function as an antifreeze but as a cooler. No water is used, because the jacket temperature approximates 250° F. The chief advantage of high temperature cooling is the reduced frontal area. The small radiator required offers less resistance than an aircooled engine of the same horsepower, resulting in greater speed. In addition, the weight of the engine is reduced as compared with an aircooled engine, which requires more plumbing and a larger radiator. A plane with a high-temperature cooled engine provides better visibility than one with an air cooled engine. The use of the glycols as high-temperature cooling agents has been extended to X-ray tubes, machine-guns, and U. S. Army tanks.

Polystyrene as Electrical Insulator

Polystyrene, a transparent, thermoplastic solid, formed by the thermal polymerization of monomeric styrene $C_6H_5CH{:}CH_2$, has been known for many years to be an excellent dielectric. The material has recently become available in the United States of America at a price which will promote much more extensive application. Polystyrene possesses outstanding low electrical power factor, high dielectric strength, great arcing resistance, and low water absorption. It has electrical properties equal to those of fused quartz, with extreme water resistance. It is being successfully used in high voltage cables, in cables joints, plugs, etc. Polystyrene films are being used as condenser foils or as cable wrappings. It can be cast, moulded, and machined into different shapes and patterns. Solutions containing polystyrene as the major nonvapourizable component have been advocated as electrical insulating varnishes.

New Ultra-opaque Porcelain Enamel

A new porcelain enamel has been put in the market. It is claimed that with the new enamel a 72% opacity reading can be obtained with 32 grams per square feet, whereas 10 years ago 246 grams of covercoat enamel were required to obtain the same results. Ultraopaque is the name given to the new material, which offers a number of advantages.

Chamber Process Sulphuric Acid Plant: A New Design

In a new design for chamber process sulphuric acid plant by H. T. Watson, Ltd. Glover and Gay Lussac Towers have been replaced by denitration and absorption chambers which are of identical construction to the main reaction chambers except that they are not

fitted with spray nozzles but have spray rotors. It has been shown by calculation that the total surface area in a chamber 10 feet by 10 feet by 5 feet with rotor sprays in operation is equal to the surface area in an average sized water cooled chamber. From this the conclusion is that if so large a surface area can be obtained by spray, there is no reason why this method will not be used in place of Glover and Gay Lussac towers. This new design means a big reduction in the capital outlay by the elimination of high towers and packings and also certain reduction in pumping costs.

Germany Saves Raw Materials

Germany is striving hard to decrease the consumption of raw materials without decreasing efficiency. To save iron and steel and to cut down the amount of steel used in building without sacrificing strength, new forms are constantly being devised. Lighter constructions using welded plate forms, for instances, instead of cast iron and steel parts have led to savings of as much as 50 per cent in weight in machine building, to 40 per cent in the underframework of passenger railway cars, up to 50 per cent in the construction of hangers, halls, etc., up to 30 per cent in street cars, and up to 30 per cent in the construction of boilers and apparatus. In shipbuilding industries, more and more ships are being constructed in Germany without the use of rivets. Considerable steel has been saved through welding; on the recently completed ship, "*Wilhelm Gustloff,*" whose hull was entirely welded instead of riveted, it was possible to effect a saving of 1,300 tons of iron and steel, which represented 14 per cent of the total of the ship.

New plastics also are used increasingly in the shipbuilding industry in place of metals for fixtures, window frames, etc. Because of corrosion resistance to salt water and sea air, plastics have numerous advantages. They are also used as wall-coverings in place of panel woods, thereby reducing the fire hazards and making considerable painting and varnishing unnecessary. Because of lightness as compared with metals, the use of plastics has effected considerable weight saving in ship construction.

Through regeneration of old materials, it was possible to fulfil 12 per cent of Germany's raw material requirements during the past year. Old paper collected amounted to over 1 million metric tons, which represented a saving of the equivalent of 1 million cubic meters of best pulpwood; 150 communities in Germany, as a result of sorting their garbage, from September 1937 to July, 1938, reclaimed 55,000 tons of scrap iron; 1300 tons of pure tin were reclaimed from old tin cans, and the total value of old materials regained was estimated at 550 million RM.

The Problem of Ferrous Industry in India

Iron has been and will undoubtedly continue to be of the highest profit to the world. Its study will always be a fascinating one and if our knowledge of it progresses as much in the future as it has in the past, then the advance will be even more marvellous. It may unhesitatingly be claimed that iron is by far the most important metal to civilization. The entire absence of what we call the precious metals, gold and silver, would but little affect our comfort or the applications of engineering and metallurgy; but take away iron and we should revert to the conditions of the Dark Ages. Iron and steel form the skeleton framework within the body of modern civilization. Without iron and steel the whole range of power-generating and power using industries would be virtually impossible. Modern building requires enormous quantities of it, speedy and abundant transportation are alike dependant upon it; communication whether by telegraph, telephone and radio is similarly bound with it. The tools of industry and the implements of war, the thousand and one essentials and conveniences of daily life are all made in whole or in part of iron and steel. The ease and certainty with which

under ordinary conditions of trade it is available to any country have led us to forget how essential it is, but in times of war or general trade disturbance a shortage of this material drives home the fact that there is an insistent necessity of iron and its alloys to modern industry and our life.

In spite of the abundance of raw materials in India and of the fact that India held a relatively high position about a thousand years ago in the world's supply of wrought iron and steel, it is only 25 years now that we find India effectively taking up the manufacture of iron to a considerable extent. During the year 1936-37, machinery (textiles, mines, paper, tea, etc.,) worth over Rs 8 crores were imported, and added to this list are over Rs 5 crores worth power generating sets, nearly Rs 6 crores worth building and sundry hardware (ropes, nails, fences etc.,) and over Rs 1½ crores worth instruments (scientific, surgical and electrical), apparatus and transmission equipments. The demand for these articles has been gradually expanding. In India the biggest enterprise in manufacturing steel is that of the Tata's producing roughly 1,200,000 tons of pig iron and 8,50 000 tons of steel a year. The steel is mostly rolled in the form of sheets, bars, rails, structural sections, plates, sleepers, tinplate, light flats wire and rod. The second enterprise is the Indian Iron and Steel Company. Its works have a combined capacity of about 8,50,000 tons of pig iron annually, together with foundries capable of producing 100,000 tons of cast iron pipes, sleepers and general iron castings. Another company, The Steel Corporation of Bengal was registered in 1937. This Corporation is under an agreement to take all its requirements of pig iron from the Indian Iron and Steel Company. The production aimed at is 200,000 to 2,50,000 tons of finished steel per annum. In South India Bhadravati Iron Works are producing charcoal pig iron to the extent of about 20,000 tons a year, most of which is converted into steel rolled in bars, hoops and other small sections. Although most of the iron thus produced is used up by the Indian market itself a fair amount of pig iron is exported mainly to Japan, the U.S.A. and the United Kingdom. It is said that for the manufacture of basic steel and for certain kinds of foundry work Indian pig iron has established a high reputation for quality in many countries. It must be pointed out here that this pig iron which is exported could have been with considerable advantage to the country, utilized in manufacturing the innumerable articles of iron and steel which are imported every year into this country. The only steels which are at present manufactured in this country are straight carbon steel. They are classified in Table I, as types 1 and 2. All the other types of steel are not manufactured here.

The Iron Age, which merged into the Steel Age when Bessemer and Siemens discovered their processes for manufacturing steel, has since developed into an era of special steels. Without iron we should inevitably revert to the importance of the Dark Ages, and without alloy steels our fate would be little better, for iron and the simpler forms of steels will not give us, the hard-wearing toughness of manganese steel; the wonderful energy-saving properties of silicon steel as used for electric generators, motors and transformers; the great reduced rusting qualities of chromium and other steels; the special magnetic properties of tungsten and cobalt and aluminium nickel cobalt steels for permanent magnets and of manganese steel for applications where non-magnetic material is required; the tough chrome vanadium steel for machine parts also the nickel iron alloy known under the term 'Permalloy' with its extraordinary high permeability at low induction. There are other steels which are strong and tough at low temperatures, steels possessing non-scaling qualities and considerable strength at high temperatures and many others to which reference is made in Table I.

From the practical standpoint the importance of alloy steels lies in the fact that they yield a greater range of mechanical properties than can be obtained in simple carbon steels, whilst they also yield either new physical properties or new combinations of properties. The wonders of modern engineering depend closely, perhaps more than is generally realised, upon the special qualities of the materials employed. It is important to remember that engineering science has progressed succesfully just so far as the properties of the constructional materials available would permit. Improvements in material have been followed immediately by advances in engineering practice. According to requirements it is possible, by the use of alloy steels, to reduce the weight of parts whilst retaining or increasing their strength, to obtain strength combined with special ductility, hardness or resistance to fatigue: and in fact, to obtain or accentuate almost desired physical property.

It is of utmost importance to this country that the metallurgical technique of preparing these alloys should be systematically and thoroughly developed. The works of the Tatas at least are so developed that without much difficulty the methods of preparing these alloys with the proper physical properties can be evolved and standardised. It is understood that Tatas prepare such alloys as are needed for their own consumption although their needs is almost insignificant even in variety as composed to that of the general engineering industry. In order to prepare these alloys efficiently and economically, it is further essential to prepare in this country ferro-alloys *e.g.*, ferro-chrome, ferro-manganese, ferro-silicon, ferro-tungsten, ferro-vanadium etc., of requisite purity. It is through these compounds that the alloy steels are prepared. Most of the raw materials for preparing these ferro-alloys are available in an excellent quality in India and are at present exported for the preparation of such alloys. Even the Tatas do not manufacture their requirement of ferro-chrome at their works but import it from outside. These alloy steels and ferro-alloys when they will be manufactured in India, will naturally be small in quantity. This should not, however, be a source of discouragement. Even of the annual consumption of any particular alloy be the output of just one charge of an electric furnace or small open hearth furnace, it would be of great advantage to manufacture it. It would not at all be uneconomic.

Having seen what we have got to do with respect to materials of construction, let us see what processes, if any, we need developing here before we can claim to have acquired the best of the present industrial civilisation. The most important process is the casting of ferrous alloys. The facility with which iron can be cast into as intricate a shape as the designing engineer can imagine, its ease of machining, ability to withhold fairly high pressure and the low cost, recommend it for innumerable applications. It is favoured in many instances because of its reliability and because it may be cast in a simple piece, thereby eliminating joints which are a frequent source of trouble. The use of cast iron eliminates the possibility of any galvanic action at the point of contact between different metals or between a weld and adjoining metal. In recent years cast iron has been improved in quality by refinements in foundry practice, by altering the basic ratios of carbon and silicon and more recently by the addition of alloying elements. It can be made in such a manner that the dimensions will be sufficiently accurate to allow the use of close fitting working parts. An important disadvantage to cast iron for use at high temperatures has been its tendency towards growth, as much as 30% increase in volume in some cases. Through the use of alloys and better melting, this characteristic property can now be controlled, almost to the vanishing point and cast iron is now recovering a good deal of the ground lost due to this defect. By the use of alloy cast iron and improvement in foundry practice and heat treatment almost any property has been developed in ferrous castings.

Although a considerable amount of ferrous casting has been and is already produced in this country and there are several foundries working in various parts of the country, they deal only in pig iron and mild steel casting. All the recent advances made in the foundry practice, metallurgy and heat treatment of iron and its alloys are unknown in Indian foundries. As a result of this the development of modern engineering *e.g.*, production of machines and power plants has not had much scope. Whatever little we see is a consequence of import from foreign countries, connoting an inordinate drain of Indian wealth and a helpless dependence on foreign countries. It is true that a lack of development of proper materials has contributed in no small degree to a backwardness in the casting industry of the country, but the major part of the blame lies on the Indian foundries. It is they, who did not progress at all although they had a huge market at their very door of all sorts of machines, power plants and other engineering products. The equipment at the Tatas has been such that before long proper materials both alloy steels and ferro alloys would have been available in this very country. What lacked was the existing knowledge of the advances made elsewhere in the processes connected with ferrous casting and the technique developed. We see some oil engines, made in India, selling in the market, but they are miserable specimen of such engines. The defect is not so much in design—they are a copy of foreign makes with precious little changes. The fault lies in the use of improper material and in the ignorance of uptodate foundry practice. It is this particular science (it is no longer an art as it was in the last century, but has attained the precision and exactitude of a regular science) that needs fast development in India. There is no dearth of engineering talent

here. In engineering colleges and institutes extremely complicated and difficult designs are executed. They are, however, all on papers to be pigeon-holed and wasted. They can be easily translated into real machines. Such procedure will serve a dual purpose; it will improve designs and help the foundries. The Indian market will have efficient and comparatively cheap machines and their money will remain in this very country.

From the earliest day in the history of modern alloy steels it has become increasingly apparent that heat treatment is at least as important as chemical composition in determining the properties and practical value of steels. Today it is generally recognised that proper heat treatment is essential to the development of the best characteristics in most steels. The fact that heat treatment is an essential factor in the preparation of alloy steels for service, and the remarkable results thus obtained, led to an increased appreciation of the possibilities of heat treatment in connection with carbon steels. The advance in knowledge concerning alloy steels reacted, in fact, upon the technology of carbon steels and led to the discovery that properly treated carbon steels are comparable with the more expensive alloy steels in many applications. Equally important is the knowledge of tempering, normalising, carburising, case hardening and nitriding of the various alloys of iron including straight carbon steel. It would be difficult to over-estimate the importance of heat treatment to this country. The acquirement of that knowledge and the development of its technique is as much important as that of casting. Unfortunately this knowledge is conspicuous by its absence in India. Even such a big concern as Tatas have to import the chill cast iron rolls for their mills from foreign countries, although they can be manufactured here, provided the proper casting technique and heat treatment to be given to them is acquired. Without the development of this branch of science, India, cannot think of manufacturing any machine or power plant.

Another science in metallurgy which has jumped up recently is that of welding. It is finding great application in engineering. Although it is not of such a vital importance as casting and heat treatment, its knowledge will go a long way off to solve the industrial problems of India.

Finally comes the problem of forging including die and cold forging and of machining. Machining is not so difficult as other things are. Indian workmen have picked up this art quite well but we lack in equipment. Want of equipment is a part of a bigger want *i.e.*, of machines and power plants in this country for use in the various industries. The machinery when imported become so very costly that, with the funds available in the country, the capital cannot be sunk in purchasing sufficient quantity of them. The solution of the machine problem as indicated above will go to solve this problem of want of equipment as well.

The question of forging requires a closer attention. Its successful working needs a better knowledge of the properties of the ferrous materials by Indian workers and a better mastery of technique. It is anticipated that if the above mentioned defects are remedied this defect will also be taken care of. We look to Tatas and the Indian Iron & Steel Co., with the lavishly equipped research laboratory of the former to take up the technical solution of them and hope there would be co-operation enough between the various experts as to solve the difficulties.

We cannot close without considering the problem of coal, so important to any industrial enterprise. Iron ore without coke is virtually useless. A limited amount of iron is still made by using charcoal, but, having in mind the speed, capacity of furnace and standard technology, no large iron industry can be expected to develop without the use of coke. Attempts have been made and experimental work is now under way in various countries to produce iron by direct reduction in the electric furnace, or by making sponge iron first (for which purpose inferior coal may be used) and then melting that in the electric furnace. This process if possible technically and in whole or in part will doubtless in time find application in special instances; but in speed, capacity and cost, it does not compare with manufacture by the usual method of employing blast furnaces and open hearth or bessemer converters. Coal is thus the second of the minerals that must be commended in sufficient quantity by a nation expecting to play an important part in the world's industrial activity.

Notwithstanding large reserves of coal, there is doubt about the adequacy of the coke supply in India. A committee of the Govt. of India appointed in 1920.

indicated the probable exhaustion of the coking coal within forty years at the present rate of use, but later discoveries are said to have increased the known reserves. Much of the coal is vitiated by high phosphorus and ash content. With the limited supply of coking coal in India, there is an imperative necessity of enforcing a policy of strict conservation of coking coal (see the editorial in our March issue). We trust the nation will soon pay due attention to this problem and the enormous waste of the coking coal especially by the railways and other public works will be a matter of the past.

Utilization of Scrap Iron in India

A country progressing industrially consumes more and more iron. India it at present using about four million tons of iron annually, and there is no doubt that the amount of consumption will increase year after year. Our country is fortunate enough to possess a number of large tracts of iron ores, some of which are being worked by iron and steel companies. These are meeting the present-day demands of the country and will also no doubt be able to cope with increasing demands which may arise in future. Since, however, iron is a metal essential for industrial development the problem of its conservation has to be seriously thought of and to the prevention of the waste of this most valuable metal we ought to give close attention. Let us think for a moment as to what happens to the vast amount of iron that is being consumed daily. The iron material that we are using today will have to be replaced some day or other by fresh material. We can count a thousand and one way in which iron is rejected by the wear and tear in every day life and in industry. Needless to say that iron which is rejected does not lose its metal value immediately. It is rejected simply because the machines and articles made of it becomes inefficient for the particular purpose for which it was prepared. A broken machine, worn out rails, rusted iron materials are rejected as they can no longer be used for the respective needs. But the metal value of the rejected iron or scrap iron as it is usually called, remains intact. If not properly utilized the huge amount of scrap iron that is being accumulated will produce if allowed to waste, a heavy drainage of national wealth. We propose to discuss in this article how the scrap iron may be utilized.

Metallurgically scrap iron may be broadly classified under two heads: (*i*) Cast iron scrap. (*ii*) Steel scrap.

Cast iron scrap Cast iron is widely used in trade and commerce and consequently the output of cast iron scrap is quite large. This form of scrap iron comes mostly in the form of broken machinery, agricultural implements and rejected railway materials. Cast iron scrap obtained from these different sources, may further be classified according to the carbon and silicon content. Fortunately enough, the entire amount of cast iron scrap is consumed by India herself. The various different small iron foundry works scattered all over India use the cast iron scrap as it can be melted down at a comparatively lower temperature (600-800°C). The different varieties of cast iron scrap are mixed with different amounts of pig iron and are cast in moulds.

Steel Scrap Steel scrap comes mostly from the railways and a portion from the engineering firms. Apart from the classification of steel scrap from the point of view of carbon content, steel scrap is classified according to the size and the particular purpose that it can serve. Prior to 1936, the entire steel scrap output of India used to be exported to Japan and a few other countries. Since then, several rerolling mills, as they are called, have been started in the different provinces of India. Steel scrap obtained in the convenient form of railway tracks, tyres, railway springs etc., are heated to the required degree of plasticity and may be drawn out into rods, bars, or wires. In the various rerolling mills, this form of steel scrap which we may

designate as class (*a*) are first cut down to proper sizes by a shearing machine and are heated in a furnace and rerolled as mentioned above. In class (*b*) we can place the huge amount of shapeless steel material and those of less convenient size which can not be rerolled in the above manner. This class of steel scrap is still being exported to Japan. A small fraction of steel scrap which can be suitably utilized locally by the blacksmith is placed in class (*c*). The blacksmith heats this form of steel scrap to the required temperature and prepares mostly agricultural implements.

In the market steel scrap is conventionally classified, according to the size of the scrap material as follows:—

Class I—Pieces of size $\frac{3}{8}''\times 2''$ 5′. Class II—those of thickness between $\frac{3}{8}''$ and $\frac{1}{4}''$. Class III of thickness between $\frac{1}{4}''$ and $\frac{1}{8}''$ and Class IV—borings and turnings.

Of these different varieties of steel scrap of various sizes and shapes, those of the first three classes are being turned into good use in India by a number of rerolling mills.

Other varieties of steel scraps may also be made useful but before that it is necessary to smelt them and obtain billets of proper size and shape. There are a number of factories in India which do this to a moderate extent.

Total amount of steel scrap thus utilised in the country is not very large and a huge amount of the material is still being exported to Japan.

A Table below shows the amount of steel scrap which is exported annually from India.

	12 months, 1st April to 31st March.		
	1935-6	1936-7	1937-8
Amount Exported (in tons) ..	57,634	105,857	57,477
Cost in Rupees ..	13,44,321	29,07,968	20,25,885

It will be seen from the above Table that there is an abrupt decrease in the amount of steel scrap exported during the year 1937-38. This is due to the fact that several rerolling mills started working during this period and the steel scrap thus utilized and stocked for the purpose caused a decrease in the amount exported.

The problem of utilizing the steel scrap thus devolves upon the method of smelting steel scrap at a low cost. There are at present at work two processes of smelting steel scrap. The first is the ordinary method of smelting in the open hearth furnace. This process though very simple and convenient is comparatively costly owing to the high price of pig iron. The other process is that of smelting in the electric furnace. The working of the electric furnace is very interesting from the technical point of view. The furnace is made up of steel sheets at the outside and is covered up with fire bricks at the inside. There is also a final coating of dolomite on the inside surface of the chamber. Scrap iron materials are placed inside this chamber. There carbon electrodes which can be raised or lowered mechanically are maintained at a high voltage. As the three electrodes come in turn within a certain distance from the scrap material a heavy spark passes. Thus a series of sparks is maintained on the "charge" as the electrodes are successively brought within the sparking distance. Generally it takes about 8 to 10 hours to melt down the "charge" when the furnace is working efficiently. When the "charge" has melted down altogether, it is the business of the metallurgical chemist to add or burn out the requisite amount of carbon to get the steel of the required specification.

With the rapid advance of industries in India, the problem of scrap iron will become more important than at present. The cost of the various types of scrap iron that are at present available in the market is determined by the demands and the respective purposes that they can serve. Cast iron scrap sells at a price of about Rs. 55-65 per ton whereas steel scrap sells at a price ranging from Rs. 10-35 per ton. Rerollable steel (*rails*) brings at present a price of Rs. 50/- per ton. Blacksmith's materials has a wide range of price from Rs. 40-90 per ton depending on the material that can be made out of it.

It may be remarked in conclusion that utilization of scrap iron is a lucrative industry. Although the conversion charges are high yet the overhead charges are low. This interesting industry will become more important if electric power can be obtained at a cheaper rate and if open hearth furnaces are built on modern lines to work more efficiently at a lower cost.

A. K. B.

Medicine and Public Health

Rockefeller Foundation and Medical Advance

The question of private versus public support for research has recently come up before the public. The report of the Rockefeller Foundation for 1938 draws attention to the Division of Laboratories and Research in the New York State Department of Health and also notes that the British Medical Research Council, another government organisation which receives £195000 a year from the Treasury has shown a uniform standard of quality and imagination in its work and has avoided any danger of political influence. Without in any way minimizing the value and significance of publicly supported research, it is however undoubtedly a fair statement that in private institutions originality, spontaneity of thought, variation, independence, conviction and tenacity have had a peculiarly rich soil in which to flourish. But private organisations cannot dream of matching the sums for research to which the Government has access. During the year 1938 by a single appropriation, the U. S. A. Congress made available for research in cancer a sum of money for annual expenditure that is comparable in amount to all the grants from private source in the United States put together. On the other hand, the actual decrease of research funds in private institutions presents a problem of crucial importance which is involved with larger questions relating to the whole future of universities, institutions and laboratories dependent on private sources for support. Though the report is based on the conditions in U. S. A., the situation in our country is also the same. As far as medical research is concerned it would be a tragic outcome if through lack of adequate funds the initiative and intellectual leadership which these private institutions have given to medicine were gradually crippled or curtailed. During 1938, the Rockefeller Foundation has appropriated more than 50,00,000 dollars to the study of medical sciences. The subjects chosen are psychiatry, neurology, etc., and the centres of study and research are mostly in the home country. Of the total of 3,800,000, dollars excluding grants according to former authorization appropriated during the year, roughly 1,200,000 dollars was devoted to the general field of mental hygiene; 2,600,000 dollars went for other types of support. This ratio does not mean that the Foundation's primary and long-time emphasis has been altered. It means rather that the Foundation does not hesitate to step outside its own self imposed limitations if more significant opportunities appear. The reason that the Rockefeller Foundation, in the medical sciences, is concentrating its efforts on mental hygiene is because it believes that at the moment that field represents one of the most underdeveloped areas in all medicine. In no other field is the need more desperate or the potentialities for useful advances more promising.

The report further points out promising paths where large sums should be devoted to teaching and research. The applications of sulphanilamide, tryparsamide in African sleeping sickness suggest the possibility of more chemical compounds synthesized in the laboratory with specific actions on the infective organisms causing particular diseases in man and animals. Then there is the subject of dermatology. The skin protects other organs of the body from external injuries and particularly from the effects of temperature variations, and more detailed study of it will reveal interesting facts. The report regretted that pharmacology, legal medicine (application of expert medical knowledge to the administration of justice) industrial medicine (to provide expert advice and direction to industries confronted with the health problems of the personnel) and dentistry are yet to develop in the U.S.A. We may pause to take stock of the position of these sciences in India! Effective institutes for the study

and prevention of industrial diseases have been established at Moscow and Leningrad, and a great museum designed to show health hazards in mines and factories has been organised at Kharkov. Similarly the Kaiser Wilhelm-Institut fur Arbeitsphysiologie at Dortmund, Germany, is without paralell in the United States. Dentistry in America is based more upon ingenuity of mechanical sort than upon the amount or character of research done on the anatomy, pathology or physiology of the oral cavity. No research has yet been possible in this branch comparable to research on medical and surgical problems. Preventive medicine and public health constitute another scope of intensive study. Still another neglected area consists in the disease of the advanced years, the circulatory failures, high blood pressure, chronic kidney disease, rheumatism and faults of nutrition.

The report gives descriptions of two important works and are reproduced below.

A year ago the Foundation announced the successful development in the laboratories of its International Health Division of an effective virus (known as 17 D) for vaccination against yellow fever. While vaccination promises to be of great aid in preventing the transfer of yellow fever by the human host from one locality to another, it cannot of course eliminate the virus in the jungle nor block its dissemination through contiguous forests in the tropics. Lurking somewhere in these forests are unknown vectors and other hosts than man; and a great deal of work remains to be done before they can be accurately identified. Field work by the members of the Foundation's staff during 1938 resulted in the capture of three species of mosquito, other than aegypti, infected with yellow fever virus. Moreover, the bodies of howler monkeys were discovered in the woods where they had died at the time human infections of yellow fever were occurring in the same areas. Up to the present all attempts to isolate yellow fever virus from wild animals have failed.

It is difficult to fit all the observed facts into any simple mosquito monkey-mosquito cycle of infection, and the search is continuing for other factors. Jungle yellow fever occurs under such a wide variety of natural conditions that it seems reasonable to anticipate that no single set of factors, operative throughout, will be discovered.

* * * *

Anopheles mosquitoes are malaria carriers; the Anopheles gambiae is the dangerous member of a dangerous family. Although the species has hitherto been reported from Algeria and Morocco, and from Southern Arabia as well, its principal home is the African tropical belt, extending from the southern border of the Sahara desert south to the Zambesi river. It is the scourge of central Africa, a carrier of a serious and often fatal type of malaria, sometimes complicated by the so-called "blackwater" fever. Until 1930 this species of mosquito was not known on this side of the Atlantic. In that year, however, or shortly before, it crossed the ocean apparently by airplane or on one of the fast French destroyers which at that time were working in connection with the French air lines between Dakar in West Africa and Natal in Brazil. The species was first discovered in 1930 within the city limits of Natal by Dr Raymond C. Shannon, a member of the Foundation's staff, during a rountine mosquito survey in connection with the yellow fever service. The seriousness of its presence was immediately recognized but it was hoped that the invasion might be localized by natural conditions unfriendly to the invader.

These hopes were disappointed. In 1930 and 1931 there occurred in the vicinity of the breeding area in Natal an outbreak of malaria of a severity unprecedented in the annals of the city. The yellow fever service was compelled to undertake gambiae control in order to maintain an efficient staff for its own work. By 1931, following prevailing winds, gambiae mosquitoes had travelled up the coast 115 miles. Two years of severe dry seasons seemed to check the invasion, and then, with the recurrence of normal rainfall, the onward flight started again.

In recent years, severe epidemics of gambiae carried malaria have occurred in localities over two hundred miles west and north of Natal. In the Jaguaribe valley of the state of Ceara alone there were over fifty thousand cases of malaria in 1938. Over 90 percent of the population was affected, with mortality in certain districts estimated at 10 per cent. So disabling and widespread was the epidemic that in some parts crops were not planted and salt production was greatly reduced because of lack of a labor. It is estimated that as a result of the ravages of this mosquito nearly every person in these affected areas will be on government relief in 1939.

MEDICINE AND PUBLIC HEALTH

Flat Chest against Tuberculosis

As a result of several thousands of normal and tuberculous chests, Dr S. A Weisman has come to the conclusion (*Your chest should be flat* by Dr S. A. Weisman, Assistant Professor of Medicine, University of Minnesota, published by J. B. Lippincott Company, New York, 1938;) that the deep chest makes better soil for tuberculosis. He has based his observations on a determination of the "thoracic index" (*i.e.*, the ratio of the depth of the chest to its width), the vital capacity and other measurements. The round shape of the chest in tuberculous individuals occurs in cases where the chest does not flatten with age. The thoracic index has been found higher in tuberculosis and still higher in chronic bronchitis and asthma.

It has been shown that the thoracic index falls in the case of boys from 72 at the age of 5 years to 67 at the age of 18, while in girls it ranges from 71 at the age of 5 years to 70·4 at the age of 18. Up to the age of puberty there is no very clear difference in chest contours of the two sexes. After puberty, however, the boys' chests are flatter than those of girls of the same age. It decreases steadily in both sexes as height increases and also as vital capacity increases. Environment has a definite influence on chest development, children from good environment showing on the average a much better type of development than children from poor environment. The factors which have been generally noticed in association with the deep chest are: weight and height below normal for age, poor socio-economic environments, lower than normal standing in school work and tendency to positive tuberculin test. The author thinks that the deep narrow chest offers a more favourable soil for the development of tuberculosis than does the flat and wide chest.

The author considers that the normal development of the chest and the early correction of its physical defects are likely to be vitally important in preventing tuberculosis and emphasises that, for early detection and correction, the tuberculin test and chest measurements should be a routine procedure in the medical examination of children. Diet, environmental adjustments, suitable physical excerise and a periodic medical check up for all children have been advised as some of the correctional procedures.

Hygiene of Housing

The problem of housing, in rural and urban areas, especially in its scientific aspects, and its relation to individual and public health, has engaged the attention of sanitarians, engineers and governments in Europe and America. A lot of scientific work has been done on the subject. The Health Organisation of the League of Nations has been interested in the problem since 1931 and has incorporated the results of their studies in a report of the Housing Commission in a recent issue of their Bulletin (Vol. VI, Extract No. 12).

The programme of studies included the following items:

(*a*) Hygiene of the environmental conditions in dwellings, (temperature, purity, humidity, movement of the air and temperature of the surroundings.)

(*b*) Noise and housing;

(*c*) Insulation;

(*d*) Natural and artificial lighting;

(*e*) Density of the population, "Zoning" and open spaces (Gardens, parks, playgrounds etc.);

(*f*) Smoke abatement and air pollution;

(*g*) Methods of water supply; sewage, waste and garbage disposal;

(*h*) Administrative and legislative aspects of housing hygiene;

(*i*) Definition of healthy urban and rural dwellings, as well as healthy cities and rural areas (regional types of urban and rural dwellings and of urban and of rural planning).

One of the primary objects of housing is to protect the individual from climatic discomforts, especially heat and cold. The environmental conditions inside the dwelling which provides this protection must accordingly be such as to permit the maintenance of equilibrium between the production and the loss of heat from the human body. In addition to facilitating the maintenance of thermal equilibrium, environmental conditions should be such as to promote physical and mental fitness and the feeling of well-being.

The chief environmental factors which influence the maintenance of thermal equilibrium are: the dry bulb temperature, humidity, movement of air and the mean radiant temperature of the surroundings, includ-

ing walls, flooring, ceiling or roof, windows, heating appliances and human bodies. Instruments like the ordinary thermometer, Katathermometer (Hill), Eupatheoscope (Dufton), Globe thermometer (Vernon), resultant thermometer (Missenard), Thermo integrator (Winslow & Greenburg), heated Globe thermometer (Yaglou) and Frigorimeter (Dorno) have been used to measure the factors which influence bodily heat exchanges.

English authorities approve for the home or similar conditions a range between 60°F-68°F (16°C-20°C), while in the U.S.A. 65°F-70°F (18°C-21°C) is the favoured range with minimum air movement and wall and air temperature the same. In France, a resultant temperature of 61°F-65°F (16°C-18°C) is recommended for dwellings (normal clothing and activity). The degree of air movement recommended by English and American hygienists varies between 10-15 feet per minute, whereas German hygienists recommend that it should be 80 feet per minute. As regards moisture, American hygienists are in favour of a relative humidity of 35%-65%, Germany 25%-40%, Netherlands—50%-80% and England—25%-70%, when the air temperature ranges between 60°F-70°F (16°C-21°C).

Attempts have been mad to study the co-efficients of heat transmission of building materials and to estimate, for instance, how thick a wall is to be built of a given material in different climates, to provide the optimum conditions of comfort with the minimum expenditure on heating and cooling the building. Actually rules for calculating the heat requirements of buildings have been framed in America and Germany. The system of heating, cooling and air-conditioning, as well as ventilation, has received considerable attention from various workers but the standards vary in different countries.

The effect of sound and noise on the human organism has also been studied.* The power or energy of noise is usually measured by microphone-amplifier instruments, while the loudness may be measured by either subjective or objective meters, the latter being essentially microphone-amplifier instruments specially modified to simulate the acoustic characteristics of the ear for different types of noise. The unit of measurement of noise is *decibel* in some countries and the *phon* in others. For example, a slight rustling of leaves gives 10 decibels and ordinary conversation gives 60 phons, while the limit of pain is given by 130 phons. Various measures have been devised to reduce noise in the home and in streets. The subject of transmission of noise by building materials has also received attention.

It is a matter of great regret that hardly any work seems to have been done in India on this subject. Our engineers and scientists do not yet possess sufficient basic data to advise people on these subjects.

*It will be interesting to read the article on the ANALYSIS AND MEASUREMENT OF SOUNDS elsewhere in this issue.

Health of University Students in Bengal

The annual report of the Students' Welfare Committee, University of Calcutta, for the year 1937-38 makes interesting reading. The Medical Board attached to the Committee visited a number of institutions during the year and examined the health of 2,777 students (college students 354, school students 2,423). This brings the total number of students examined by the Committee to 37,043. Each student examined was supplied with a report on the state of his health. A copy of the report was forwarded to the institution concerned for information and a third copy was preserved in the department for reference and investigation. This new arrangement, introduced during the year under consideration, has added considerably to the routine work of the office. But the additional work will be amply repaid if it induces the student to take a greater interest in his health preservation. In addition, separate reports on the state of health of the students examined were sent to the institution concerned shortly after the completion of the medical examination. These reports contained a list of students found to be suffering from any diseases or defects together with the recommendation suggested for rectifying them.

The proportion of students suffering from diseases or defects requiring immediate attention was 41·6% as compared with 53·6% for 1936 and 63% for 1935. This is the lowest percentage as yet obtained and indicates that there has been a perceptible improvement in the health of the students. There has been a decline in the incidence of diseases on all heads except affections of the lungs, heart and pyorrhoea. The incidence of malnutrition has come down this year to 23·4% among college students and 31·1% among school students, *i.e.*, much below the usual figures found in other years. The

decline in the incidence of malnutrition indicates that the students and their guardians are taking a greater interest in the preservation of health. The incidence of students requiring immediate medical attention has declined from 66% for the triennium 1920-22 to 41% for 1937. This general improvement of students' health seems to indicate that the work of the Committee has begun to yield the results hoped for when it first began its work in 1921. The effects of the last recrudescence of epidemic dropsy in Calcutta is still distinctly seen in the higher incidence of affections of the heart among both groups of students. The number of defect cards issued by the Department during the year was 1,664; 500 students were called up for reexamination and out of these 200 were kept under observation for varying lengths of time. Arrangements were made for special examination in 8 cases. The eye clinic attached to the Committee was largely utilised by the students; 1,040 examinations were conducted during the year.

Diet of the Students

Until now both in India and abroad the value of important food ingredients has been measured from a study of the consumption of raw foodstuff. Such methods are open to the criticism that the values of the foodstuffs are considerably changed during the process of cooking and a correct evaluation of the actual consumption from the nutritional standpoint cannot thereby be obtained. Hence it was considered desirable to gather information about the protein and mineral values of the diet as they are actually consumed by students in Calcutta hostels. During the year under consideration 144 diets from 8 different students' hostels and messes were analysed with a view to find the actual calcium, phosphorus and ionisable or assimilable iron intake per head per day. The investigations have yielded the following results:

"(*a*) The assimilable iron intake varies from 6·56 mg. to 7·97 mg. per head per day. Considering the optimum intake to be in the neighbourhood of 10 mg. (after Stiebeling of the U.S.A. Bureau of Home Economics), this intake seems to be appreciably low. The total iron intake, however, is fairly large as it varies between 30 and 40 mg. per head per day.

(*b*) The calcium intake per day varies between 0·6 gr. to 1·2 gr. Considering the optimum intake to be 1·0 gr. some of the diets consumed seem to be slightly low in calcium.

(*c*) The phosphorus intake per head per day varies between 0·9 gr. to 1·1 gr. Accepting the optimum phosphorus intake to be 1·0 gr. to 1·3 gr. the usual phosphorus intake seems to be sufficient."

In addition, about 25 common Bengali foodstuffs have been examined for calcium, phosphorus and ionisable iron contents. Of these the papaw, potato, cauli flower, sweet gourd (kumro) and French beans are good sources of assimilable iron. *Danta, shak, amra,* papaw, beans and turnips are good sources of calcium. *Karala, mocha, ucheche,* papaw and *amra* are good sources of phosphorus.

Sixth Triennial Medical Survey, 1936-37

With a view to determine the trend of growth and health of the Bengali student from year to year the Committee has systematically recorded certain measurements of every student examined by the Medical Board. The measurements used for judging physical development are:—height, weight, height-weight index, chest girth and strength of grip. For determining the general health of the student community, the incidence of the following defects and diseases have been calculated in trienniums, *viz.*, malnutrition diseases of the respiratory and circulatory systems, incidence of dental caries, enlarged spleen, enlarged liver and congested throat. From an examination of the data the following conclusions can be drawn.

(1) The average height of the students in age groups 16-22 steadily increased till 1928 after which it showed a slight decline and the figures for the triennium 1935-37 are slightly lower than those of the triennium 1929-31, but the averages for the age groups 8-15 are slightly higher than those for the triennium 1929-31.

(2) The tendency to increase in weight has, however, been maintained and the averages for the triennium ending 1937 are on the whole higher than those for the previous triennium, except for the age groups 8 and 16.

(3) The height-weight relationship as shown by the Ponderal index has remained at the same level as in 1931 for the age groups 16 to 22. It shows that we are having a larger number of well-nourished students.

(4) The averages for the chest girth during inspiration shows a slight increase for the triennium ending 1937, the average capacity for expansion, however, does not show any definite increase.

(5) The strength of the grip which remained more or less steady till 1934, shows a slight increase for the age groups 12 to 22.

(6) A survey of the incidence of various defects and diseases among students reveals that malnutrition has steadily decreased among the college students since 1920. This undoubtedly *is* a welcome feature but the incidence of malnutrition among our students *viz.*, 25%, is still higher than the corresponding figures for other countries. The same remark may also made for the number of students who require immediate attention and treatment; the incidence of this has decreased steadily from 66% in 1920-22 to 41% for the triennium, 1937.

But this decrease has been chiefly in the group of diseases usually classed as minor ailments, *viz.*, bad throat, diseases of the skin, etc. On the other hand, the incidence of students suffering from affections of the heart and lungs shows a slight increase.

To sum up, the survey shows that there has been a perceptible improvement in the physique and health of the students. The average student of 1937 is taller, a more robust and a more healthy person than the student in 1921. But however welcome this finding may be, it must be pointed out that the standard of physical level achieved is still considerably below that for students of Western countries. It merely indicates that the health and physique of the Bengali student can be improved considerably by sustained well organised efforts. Sports, gymnastics and educative propaganda received their share of attention. On the whole, the work reflects great credit on the committee and its medical officers.

Role of Iron in Nutritional Anaemia

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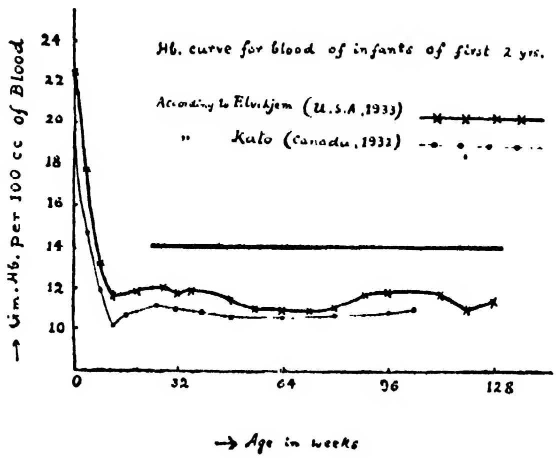
It is now generally agreed that the administration of iron is remarkably effective in the treatment of certain types of anaemia. Of course, it would be quite logical to expect this efficacy of iron—a substance that always symbolises with an idea of some strength in amelioration of conditions that are characterised by lassitude and weakness. In practice too, iron, *e.g.*, '*Lauha Vashma*' (calcined iron), '*Nabayasa Lauha*' (iron nine times macerated) etc., has been successfully applied to the treatment of anaemia in this country from a period as early as the Buddhistic régime. In the West it was, however, introduced only in the middle of the 17th century. Its definite mode of application in modern clinical medicine dates from 1831 when Bland introduced a mixture of ferrous sulphate and potassium carbonate admixed with mucilage tragacanth in the form of pills. This method of iron administration was being followed when Bunge (1884) pointed out that inorganic iron is not absorbed from the intestine and is converted into sulphide. He further suggested that our foodstuffs also contain iron in the complicated organic form built up during the life processes of the plants. It is in this form that the iron is absorbed and assimilated. This observation subsequently stimulated the use of complex iron derivatives like haemoglobin, haematin, iron-peptonate etc., in anaemia. Extensive researches during last few years have again revealed the importance of inorganic iron for the formation of haemoglobin of our blood and thereby confirmed the importance of inorganic iron for the formation of haemoglobin of our blood and thereby confirmed the red pigment of blood, for the treatment of anaemia long ahead of the present day advanced therapy. Iron is now the most excellent remedy in treating the disease

in which there is primarily a deficient formation of haemoglobin, the so called 'hypochromic' anaemia.

The reason for this deficiency are believed to be due to: (*a*) deficient intake of iron or iron-containing foods either for economic considerations or due to ignorance; (*b*) increased demands, as in external blood loss in infancy and pregnancy; (*c*) defective absorption and retention due to various pathological conditions; and (*d*) a combination of any two or more of the above factors. Naturally the persons who are liable to suffer most would be poor people, growing infants, girls after puberty, pregnant and nursing mothers and those who have been infected with malaria, kala-azar, hookworm etc. But anaemia itself is mainly nutritional in origin, as is evident from the fact that the addition of iron to the diet prevents its occurrence, or if it is already present, very soon effects a cure. Infants who are fed exclusively on cow's milk or even weaned over prolonged periods suffer from iron deficiency because milk, in spite of its nearest approach to a complete food, is deficient in the substance which is essential for blood building. In cases of women, it is motherhood, as pointed out later on, which is the deciding factor. In adult males, no such deficiency should occur if the diet is proper and well-balanced, and if they do not suffer from any infection of the type already referred to. A recent survey (*cf.* Report of the Students' Welfare Committee, University of Calcutta, 1937-38) shows that though the total iron intake by the college students residing in the university hostels, Calcutta, varies from 30-40 mgms., the amount of iron that may be available for assimilation does not exceed 8 mgms. per head per day; whereas according to Sherman (1937) 12 mgms. of food iron per day are considered to be a satisfactory standard. The amount of iron that might be available from a well-balanced diet, particularly in Bengal, comes to about 13 mgms. (*cf.* Goswami and Basu, 1938).

Iron in Infancy

The recent researches (Mackay, 1931; Elvehjem *et al*, 1933; Usher *et al*, 1935; and others) have revealed that infants particularly those who are being artificially fed, suffer from a type of anaemia in which there is primarily a deficient formation of haemoglobin. This appears to a greater or lesser degree in all infants and is generally found during the latter half of the first year and throughout the second year of life. The haemoglobin level of the blood of infants though very high at birth falls rapidly and reaches a low limit within three months. Then it slightly increases but the amount varies from 11 to 12 gms. per 100 c.c. of blood during the next two years. When infants grow up and take mixed diet, this level is again found to increase gradually. Such a drop from the excessively high haemoglobin level of the normal new-born infant to a 'hypochromic' level has been demonstrated by numerous workers including Mackay (1933), Elvehjem



et al (1933)), Kato and Emery (1933), and Merritt and Davidson (1933). The phenomenon may be more clearly expressed in the graph below.

Before dealing with the iron deficiency in the food of infants, it would be of interest to refer briefly to what happens to the iron which the infant receives at birth. The body iron generally exists in three forms: (*i*) the iron of the circulating haemoglobin; (*ii*) iron stored in the liver, bone marrow and spleen available in case of emergency; and (*iii*) a small amount existing in various other tissues in an unavailable form. The infant receives this iron from the mother and consequently an early birth, twin birth or maternal anaemia would play a part in causing a deficiency in the iron store of the body. If the haemoglobin percentage of the blood be considered, then in infants the amount of iron that is present in circulating blood, is of primary importance. This would naturally depend on the initial weight at birth. In our country the babies are generally believed to have a lower weight at birth with a relatively

small volume of blood. This, in other words, means that they start with a smaller amount of blood-iron and consequently the amount of iron that would be set free and stored in the body owing to the destruction of red blood corpuscles, shortly after birth, would also be small. Now as the rate of growth of infants is rapid and as the iron content of cow's milk is low (average percentage being only 0.2 mg.), the rise in the haemoglobin level would be inhibited at an early stage for the depletion of stored iron as well as an insufficient intake of iron. The effect would be an iron-deficiency *anaemia* (*cf.* Lottrup, 1934 and Joshephs, 1934).

This deficiency is rarely a factor in the first three months (Joshephs, 1931) after birth, when the usual diet is either pure mother's milk or cow's milk diluted with water. As the infant grows, the food requirements increase; and the usual custom is to add some cereals (usually barley water) to milk apparently to increase the food value of the infant dietary. But this does not always induce normal haemoglobin formation (Elvehjem, 1934). The ingestion of eggs and vegetables, leafy and non-leafy, often produces a better result (Joshephs, 1934 and Lewis, 1931) but besides the difficulty of tolerating such a diet the response to this therapy is found to be slow and not so satisfactory. There is another question and this is on the health of the mother. If the mother of the child is anaemic, the store of iron in the liver would also be poor owing to his deficiency in the mother during her pregnancy. Infants born of such mothers are more liable to develop anaemia towards the end of the first year of life (*cf.* Parsons, 1933; Mackey and Strauss, 1933; and Paxton, 1936). In all such cases the administration of iron markedly increases the level of haemoglobin of blood. This has a greater importance in another direction as the observation of Miss Mackay (1935) has shown that a slight degree of anaemia in infants markedly lowers their resistance to disease.

But definite knowledge is lacking as to the daily iron intake essential for maintaining a higher haemoglobin level in infants aged from 3 months to 2 years. Diets providing 0·6 mg. of iron per kg. (2·2 lb.) of body weight are often believed (Rose *et al*, 1930; Ascham, 1935) to be a satisfactory standard for young children. For the older children the requirement is considered to be 0·76 mg. per 100 calories of food. If a survey on the amount of iron available from the food is made, it will be noticed, accepting the League Commission's figures and taking a mean of the amount of total iron found in the various foodstuffs, whether assayed in the East or in the West (*cf.*, Peterson and Elvehjem, 1928; Rosedale, 1935, Shackleton and McCance, 1936; Read *et al* 1937; Sherman, 1937; Health Bulletin, 1937; Ranganathan, 1938, Goswami and Basu, 1938), that the requirement of iron is in no way being satisfied. The chart below gives the results in a tabulated form.

	Foodstuff.	*Amount in Gms.*	*Iron present in MG.*	*Total iron in MG.*	*Iron Requirement in MG. By weight.*	*Iron Requirement in MG. By calories.*
Diet for infants 6 months old requiring 700 calories and weighing 16 lbs.	Cow's milk	850	1.7	2.23	4.36	5.32
	Barley ..	15	0.53			
Diet for infants 8 months old requiring 740 calories and weighing 18 lbs.	Cow's milk	850	1.7	3.67	4.90	5.62
	Barley ..	25	0.88			
	Egg ..	12	0.49			
	Potatoes ..	20	0.20			
	Leafy vegetables	26	0.40			
Diet for infants 12 months old requiring 840 calories and weighing 21 lbs.	Cow's milk	750	1.5	5.77	5.50	6.38
	Cereals ..	50	1.75			
	Egg, one ..	40	1.62			
	Potato ..	30	0.3			
	Leafy vegetables	30	0.6			

Over and above this dietary, the children are given some sugar, cod liver oil and orange juice. But the amount of iron from these sources would be negligible in the sense that the first two contain no iron and the latter is mainly a juicy product containing only 1·0 mg of iron per 100 gms of the fruit. In the

figures drawn on the chart the average percentages or iron in milk, barley, egg, potato and green-leafy vegetables have been taken to be 0·2, 3·5, 4·1, 1·0 and 2·0 mg. respectively. But it must be remembered that the food iron is divided into two classes, one in inorganic form that is available for nutrition and the other in complex form which is not set free by the digestive juices and passes unchanged. The former is now described as 'available' iron and this availability, on an average, seldom exceeds 45 to 50 per cent of the total iron when determined by the dipyridyl method. In certain cases, as for example in milk, the availibility by this method is negligible. This might be the reason for the usual custom of boiling milk in an iron can (*cf.* Basu, 1937). The major portion of this available iron may again be not 'physiologically' available when given by mouth as recently pointed out by Haha and Whipple (1938.) (*cf.* also Davdison and Fullerton, 1938.) Recently Elvehjem, *et al* (1934 and 1937) have again noticed that when the milk-cereal diet is mixed with iron salt, the average haemoglobin level in the blood of the infants considerably increases. This additional supplement or iron may raise the haemoglobin amount to 14 gms. per 100 c.c. of blood as shown in the graph by the straight line (Stephenson, 1938) and would protect the infants from deficiency disease and other infections.

Needs for Women

In women, the iron deficiency may occur due to two causes, one, defective intake and the other, increased loss of iron. Thus, in girls after puberty, iron deficiency may develop as a result of the combined demand for iron lost in menstruation and that required for growth. Besides, there might be deficiency due to diets poor in iron. For this an analysis of the diet of women in college hostels would be of considerable interest. In adult women, there is an extra demand for iron for the growth of the foetus during pregnancy and for the mother during lactation. In pregnancy, often defective gastric secretion is noticed and this undoubtedly hinders the absorption of dietary iron. The daily loss which is suffered by a woman during pregnancy and lactation for about 6 months would come to about 2 mg. Then again, repeated pregnan-result would be iron deficiency anaemia (Reid and result would be iron-deficiency anamia (Reid and Mackintosh, 1937). Orr and Clark (1930) in their dietetic survey have also noticed that it is difficult to compensate by dietary iron the iron loss which is suffered by women during childbirth. A similar observation has also been noted by Goswami and Basu, (1938). (*cf.* also Barrer and Fowelr, 1936). As a daily intake of 15 to 20 mg. ensures a satisfactory iron balance in pregnancy (Coons and Coons, 1935), it is apparent that a direct dietary deficiency plays a major part in the causation of chronic nutritional anaemia in women, particularly in pregnancy. Recently Morgan (1938) has also opined that 18 mg. of iron in the form of food or inorganic iron must be supplied to them. The haemoglobin level of the blood of college women has also been found (Duckles *et al*, 1937) to increase considerably by administration of 25 mg. of iron daily (*cf.* also Sankaran and Rajagopal). Its administration during pregnancy has been advocated by numerous workers (Metier and Minet, 1931; Strauss and Castle, 1932; Toland, 1936; *cf.* also Napier and Das Gupta, 1937).

The extra needs of iron for women, as just pointed out, for a period of about 25 to 30 years might ultimately utilise all the reserved iron stores. The result would be that an iron deficiency may arise even at the end of the reproductive period of life. This type of anaemia may be aggravated either by poor iron diet, increased iron loss or by both.

Mode of Administration

Whether in the laboratory controls or in the clinical study it has always been found that iron when given under proper conditions can be utilised for the synthesis of new haemoglobin, and later, this helps in the removal of the nutritional hypochromic anaemia. The potency of any iron preparation, however, depends upon the degree to which the iron compounds are broken down into inorganic salts by the action of gastric and intestinal secretions (Starkenstein and Weden, 1930). On this basis, haemoglobin, haemotin, iron peptonate would be poor sources of iron as they are not easily broken down to simpler form (Elvehjem, 1933) and would be practically valueless compounds (Davidson, 1933). Amongst the inorganic salts, the ferrous salts are preferred, as the belief is that the therapeutic action of iron depends principally upon its power to liberate ferrous iron in the gut. Further, the ferric iron after reaching the stomach forms insoluble salts with protein and, thereby, causes gastric disturbance. The superiority of ferrous

to ferric salt has been demonstrated by numerous workers including Parsons (1933), Davidson (1933), Lottup (1934), and Lucass and Henderson (1936). Recently Stephenson (1938) in his study of hypocromic anaemia of infants has pointed out that ferrous iron in the form of ferrous sulphate (0.4 gm. dose) is as effective as ferric iron in the form of ferri *et* ammon citrate (2 gm. dose). The latter salt has, however, a disadvantage as it requires a higher dose. The other iron preparations are reduced iron and the old Bland's pill. It has been also shown that there is little difference in the efficacy of the above preparations if the following doses are employed: Ferrous sulphate—0.6 gm. (9 grains); Reduced iron—3 gms (45 grains); Bland's Pill 4 gms (60 grains) and Ferri *et* ammon citrate—6 gms (90 grains). So the question of a better method of administration will depend on the cost, palatability and stability. The smaller effective dose of a simple inorganic salt, like ferrous sulphate is an advantage. Recently, certain proprietory concerns have also issued this in tablet form. In the treatment of infants the possible deficiency of gastric acidity might make the solid form non available (*cf.* Mettier and Minot, 1931; Joshephs, 1931); when an ideal preparation should be a ferrous salt in an elixir. These solutions are also useful vehicles in the usual treatment, particularly of small children. Still as the ferrous salt readily takes up oxygen more in solution and gives rise to a ferric one (the salt that often causes gastric disturbance), the use of a ferrous salt may be handicapped. But methods may be found by which the ferrous salt may be treated in such a way that it would remain unchanged in solution for more than a year, if not more. Further, the ferrous sulphate being efficacious in lower doses would seldom give rise to symptoms of low abdominal cramps and diarrhoea usually associated with the administration of any other iron preparation. It would be better to take a very small dose and increase it gradually so that the full dose is reached within a week. Under such circumstances it should be easily tolerated and would give no complains of any colic or loose stools.

Now regarding the dosage, it may be said that definite knowledge is scanty as to the daily iron intake whether by infants or by women. Mackay (1935) recommended 58 mgms of iron (4.5 grains of ferrous sulphate) and stephenson found 78 mgms (6 grains) to be sufficient for the infants. Glanzmann (1937) and Stolleis (1937) both using the Ferro 66 preferred 37.5 and 25 mgms dose respectively. From the nutritional point of view it has been pointed by Jeans (1936) that the diet of infants up to one year of age should be daily supplemented by 7.5 to 10 mgms of iron. Thus there is no optimum dose, and a clinical study with infants of any class or community would be of paramount importance. Another method of iron adminisstration is by parenteral injection and this method is often preferred because there are difficulties of absorption of iron from the alimentary tract but iron given by injection can be quantitatively utilised in the production of haemoglobin (Heath *et al* 1932). But injection is always painful, is not so effective (Fowler and Barer, 1937) and often gives rise to untoward results (*cf.* Witt, 1936). Iron salts are now so cheap (ferrous sulphate and ferri *et* ammon citrate being sold in the market at a rate of /10/ annas and Re. 1. 13 per lb respectively) that they can be safely given by mouth provided we remember the method of administering it and are careful about a high dose (Deobold and Elvehjem, 1935). In cases of maternity patients the dose can be increased to 3 grains ferrous sulphate four times a day during the last few months of pregnancy (Toland, 1936). It must be remembered, however, that as all individuals do not respond similarly to the same amount of iron (Heath, 1933 and Witt, 1932), it is difficult to define an optimal dose, applicable to all cases.

Factors Affecting Utilisation of Iron

The anaemias arise because of an inadequate diet, loss or faulty absorption. The proportion of iron that can be absorbed from diets and used for the formation of haemoglobin depends partly on the nature of the foodstuff and partly on the individual. The poorer retention of iron is often due to the lack of hydrochloric acid in the gastric juice. The people with achlorhydria would retain much less iron than those with normal gastric acidity (Barrer and Fowler, 1937) as the latter favours the preservation of ferrous ions. Besides, there are various other factors which are responsible for the proper utilisation of iron. Thus, copper is often found to be effective in the formation of haemoglobin when given with iron to children suffering from nutritional anaemia. But there are other evidences also which do not favour the addition of copper to iron therapy. A detailed review on this point would be found in a recent paper on diet in relation to

copper for infants by Basu (1939). It has been pointed out there that in cases of healthy and well fed children 0.4 to 0.5 mg. of copper in the form of any of its soluble salt may be added to enrich the dietary. In cases of adult women the daily copper requirement should be supplied by a well-balanced mixed diet (*cf.* Choudhury and Basu, 1939, and Davidson, 1934). Regarding other metals, manganese, cobalt, etc., it is now generally believed that they have nothing to do with blood regeneration (Waddell *et al* 1929; Underhil, 1931; Elvehjem, 1936). Certain amino-acids are often supposed to be a supplement to iron in the cure of nutritional anaemia (Drabkin and Miller, 1931 *cf.* also Elvehjem *et al*, 1931). Similarly bile pigments (Broun *et al*, 1923; McMaster, 1928) and the secondary anaemia fraction of liver of Whipple (1930) or even thyroxin in certain conditions help the iron therapy. Again vitamin C or a diet poor in calcium may prevent haemoglobin formation despite adequate iron intake. The knowledge on the actual changes that occur in the gastro intestinal tract is still meagre and a discussion on this point is beyond the scope of the present article. Those who are interested in the problem may review the artical of McCance and Widdowson (1937). There are so many etiological factors in chronic nutritional anaemia that it would be better if all individuals take a well-balanced diet including fruit juices, fresh vegetables, milk, fish and meat.

Conclusion

The above is an attempt to show that infants and often adult women are liable to suffer from a type of anaemia whose chief cause is deficiency in the required amount of iron. It is very difficult to remove this nutritional deficiency by the adustment of diet alone. Many may argue that this is a normal phenomenon as most of the sufferers never complain of any ill health. This is because those people being accustomed to live a subnormal life for years together, might have forgotten the pleasures of a sound health. But a mere administration of a few grains of ferrous sulphate considerably increases the haemoglobin level and cures the hypochromic anaemia of pregnancy. This would further help the babies born of such mothers to possess higher haemoglobin values and consequently make them less prone to suffer from anaemia. In case of infants the justification of the administration of additional iron lies in the observation that iron-fed babies are more active, possess far better resistance to infections, and would consequently survive from the high infant mortality. Thus, in short a trace of iron assists in the removal of the nutritional defects of the mother and their babies. This is of special importance to the public health workers as the health of the whole population of any country depends largely on maternal as well as on infant nutrition.

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RESEARCH NOTES

Wavelength Dependence of Nuclear Photoeffect

It is well known that under the action of γ-rays from ThC″ having a quantum energy of about 2·62 meV., deuterium nucleus is disintegrated into a proton and a neutron, because the binding energy of this nucleus is less than 2·62 meV. Of all the radioactive sources, ThC″ gives γ-radiation having the largest quantum energy, but even with this energetic γ-radiation nuclear photoeffect is not observed in other nuclei, because the binding energies in other cases are much larger than that of deuterium nucleus. In recent years, however, the invention of electric machines capable of generating a few million volts has made it possible to accelerate ions of light elements to such an extent that a large number of nuclei are disintegrated when they are bombarded by the high velocity projectiles. It was first shown by Bothe and Gentner (*Naturwiss.* 25, 90, 126, 191 and 284, 1937) that the γ-rays generated in the reaction Li^7 (p, γ) Be^8, which have a quantum energy of about 17 meV, can produce nuclear photoeffect in a large number of elements. The fact that this nuclear photoeffect is not observed with all the elements indicates that there may be some selectivity of the reactions depending on the wave-length of the γ-radiation used. It can be decided whether there is such a dependence of the reactions on the wavelength of the incident γ-radiation if the investigations are repeated using a γ-radiation having a quantum energy other than 17 meV.

Such an investigation has been carried out by Bothe and Gentner using a slightly improved technique and the results have been reported recently (*Z. f. Phys.*, 112, 45, 1938). The γ-radiation used by them in this investigation is generated in the reaction B^{11} (p, γ) C^{12} when boron is bombarded by protons accelerated by one million volts, and has a mean energy of 12·8 meV. The nuclei bombarded are N^{13}, O^{15}, P^{18}, Si^{27}, P^{30}, Cl^{34}, Sc^{44}, Cu^{62}, Zn^{63}, Ga^{70}, Se, Br^{78}, Br^{80}, Mo, Ag^{108}, Sb^{120} and Te. It has been observed that the γ-absorption spectra of the nuclei are continuous and the absorption generally increases with increase of quantum energy of the incident γ-radiation, but there are anomalies in the case of some light elements. These results are interesting from theoretical point of view.

S. C. S.

Free Radicals in the Liquid Phase

The stability of free radicals has been suggested to be due to internal resonance. Their reactions with sodium, oxygen and iodine are typical of neutral free radicals possessing an unshared electron. The source of these appears to be those molecules that readily undergo thermal decomposition at comparatively low temperatures as also photochemical reactions. It however seems to be very likely that the dielectric constant of the solvents where the reactions are performed has a large say in the formation of neutral free radicals.

The intense reactivity of free radicals other than triphenyl methyl makes their detection in solution exceedingly difficult, but, of late, quite a few cases have been reported where the existence of free radicals has been established beyond question. The existence of alkyl radicals during the photolysis of ketones in the vapour phase is well recognised, and their presence in cyclohexane solutions has been inferred (Norrish and Bamford, *Nature, 138*, 1036, 1936; *140*, 195, 1937; *Trans. Faraday Soc., 33*, 1521, 1937.)

Identical rate of decomposition of dry benzene diazonium chloride (*J. Physiol. Chem.*, *30*, 1477, 1923) in various solvents led Pray to suggest a reaction mechanism involving the slow formation of free aryl radicals from the diazo compound. This has now been confirmed by Waters (*Nature*, *140*, 466, 1937), who found that when benzene diazonium chloride decomposes under acetone the metals antimony, bismuth, lead and mercury are attacked. The formation of benzene as a result of decomposition of anhydrous nitrosoacetanilide under paraffin clearly points out the formation of free phenyl radicals (Waters, J., 113, 1937).

S. K. M.

Blue Green Algae and Nitrogen Fixation

The question of nitrogen fixation in soil from the atmosphere has been receiving the attention of the scientists from a long time. Due to its economic importance as a manure, the problem has been investigated in detail from various aspects in different parts of the world and large mass of details have accumulated as to its mechanism and agency which bring about the fixation. Mostly certain species of bacteria and to some extent a few species of blue green algae have claimed the priority as agents of nitrogen fixation, leaving aside for the present the recent researches of Dhar and collaborators who claim that fixation is brought about simply through the agency of light and the process is a photochemical one without the bacteria playing any role.

A recent contribution towards the problem of nitrogen fixation through the agency of blue green algae has been made by P. K. Dey in his work on "The Role of Blue Green Algae in Nitrogen Fixation in Rice-fields" (*Proc. Roy. Soc., London, B 127*, 121, 1939). Rice fields have a large algal population and due to its contamination with bacteria, the results obtained so far were doubted. The author has isolated from an Indian soil sample, five species of *Anabaena* and *Phormidium foveolarum* in unialgal culture. By repeated subculturing on sterilised silica gel plates three species of *Anabaena* and *Phormidium foveolarum* were obtained in pure bacteria-free cultures. After incubation for 60 days in nitrogen-free solution three species of *Anabaena* exhibited considerable increase in nitrogen and such nitrogen fixation was stimulated by the addition of small amounts of soil extract. *Phormidium foveolarum* on the other hand afforded no evidence of nitrogen fixation. It was found that a considerable part of the nitrogen fixed is found in the external medium in an organic form.

In discussing the role of bacteria in the process of nitrogen fixation in the rice fields and the possibility of nitrogen fixing algae affording conditions favourable for the activities of nitrogen fixing bacteria, experiments were carried first with the alga alone, the second, with alga + azotobacter and the third, with azotobacter alone. After incubation for two months there was found no fixation of nitrogen in cultures containing azotobacter only. The amount of nitrogen fixed by the mixed cultures did not differ from that in the cultures containing the alga only. No evidence was also afforded to suggest that products of decomposition of algae serve as a source of energy for the nitrogen fixing bacteria. The author concludes that algae can grow and fix nitrogen in the soil independently of the presence of bacteria or fungi, and that algae are the main agents of nitrogen fixation in the rice fields.

B. K. K.

UNIVERSITY AND ACADEMY NEWS

PROCEEDINGS AND PUBLICATIONS

Royal Asiatic Society of Bengal

(Calcutta, 1st May, 1939)

S. T. Moses: The Vaghers of Okhamandal.

Jatindra Mohan Datta: A new and rare type of Mughal-Pathan found near Calcutta.

K. Biswas: The rôle of the common algal communities of the river Hooghly on the drinking water of Calcutta.

B. Prashad: A historical note about the Indo-Brahm or the Siwalik River.

Indian Chemical Society

(Calcutta, February, 1939, J.I.C.S. 16, 51-113, 1939)

J. C. Ghosh: The production of optically active substances and metallic films of silver, platinum and palladium by means of circularly polarised light.

Tejendra Nath Ghosh and Debabrata Das Gupta: Pyrazole derivatives.

S. K. Ranganathan: *β-iso* propylglutaconic acid.

V. S. Puri and V. S. Bhatia: The action of inorganic colloids on electrodeposition of nickel.

B. N. Ghosh, P. K. Dutt and D. K. Chowdhury: Enzymes in snake venom. Part V. Detection of dipeptidase, polypeptidase, carboxypolypeptidase and esterase in different snake venoms.

S. G. Chaudhury and M. K. Indra: On theories of adsorption indicators.

Suresh Chandra Sen-Gupta: Studies in dehydrogenation, Part III.

Balwant Singh and Sohan Singh: Potentiometric studies in oxidation-reduction reactions. Part V. Oxidation with potassium chlorate.

U. P. Basu and S. J. Das-Gupta: Acridine derivatives as antimalarials. Part II.

S. K. Ranganathan: Experiments towards the synthesis of physiological active lactones. Part I. *cyclo*Pentyl-and *cyclo*Hexylsuccinic acids. Resolution of *dl-cyclo*Pentyl-succinic acid.

Botanical Society of Bengal

(Calcutta, 22nd April, 1939)

G. C. Chatterjee: A lump of cowdung.

(Calcutta, 18th May, 1939)

H. L. Chakravorty: Identity of *Punarnava*.

Geological, Mining and Metallurgical Society of India

(Calcutta, September, 1938, Quar. Jour., 10, 97-178, 1938.)

N. Jayaraman and K. R. Krishnaswami: A chemical and mineralogical study of a new titanium mineral from Nellore district.

S. Krishnaswamy: The heavy mineral assemblages of the Burma oilfields.

Y. T. Apte: Geology of Jamkhandi (Deccan).

N. N. Chatterjee: Sulphur study of some tertiary coals of Khasi Hills, Assam.

D. K. Chakravarti: On a *palaeoloxodon namadicus* mandible.

P. K. Chatterjee: Geological notes on the area around Khurda.

B. G. Deshpande: Geology of Vengurla Peta.

(Calcutta, December, 1938, Quar. Jour., 10, 179-214, 1938.)

D. N. Wadia: Deposits of the Ice Age in Kashmir.

Jhaverilal K. Dholakia: Sand stowing.

B. C. Roy: Economic geology of Panchet Hill.

Indian Physical Society and Indian Association for the Cultivation of Science

(Calcutta, February, 1939, Ind. Jour. Phy. Vol. XIII Pt. I.)

M. N. SAHA AND K. B. MATHUR: The propagation and the total reflection of electromagnetic waves in the ionosphere.

BHOLANATH ROY: Raman spectra of co-ordination compounds.

JAGATTARAN DHAR: Crystal structure of diphenylamine, Part 1.

M. F. SOONAWALA: The internal pressure in liquids.

D. SUBRAHMANYAM: A new theory of lapse rate.

R. R. BAJPAI AND B. D. PANT: Further studies of F-region at Allahabad.

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RESEARCH WORK IN INDIA

Government College, Lahore.

Investigations on both theoretical and experimental aspects are in progress in the laboratory of the Physics department of the Punjab University which is housed in the Government College, Lahore. Absorption spectra, hyperfine structure of spectral lines, Raman effect and nuclear reactions (theoretical) are some of the problems which are engaging the attention of research workers at the moment. Part of the work has been published while some of it was reported at the Lahore meeting of the Indian Science Congress.

Spectroscopic work—Special efforts have been made during the last few years to equip the laboratory for spectroscopic and high vacuum investigations. A systematic study of the absorption spectra due to inner electronic transitions of the various elements is being made with a one-metre normal incidence vacuum grating spectrograph between $\lambda\lambda$ 2000—500 Å. It is intended to push this range of observations still further towards the shorter wavelength region with the help of a grazing incidence vacuum spectrograph which is in the course of being installed in the laboratory. The special photographic plates, commonly known as Schumann plates, required for these investigations are being made in the laboratory and have proved to be of excellent quality—in many cases even superior to the imported plates. If properly kept in sealed boxes at 10°c in a refrigerator, these can be successfully used even a year after the manufacture. For vaporising refractory elements a high temperature carbon tube vacuum electric furnace is being employed. A liquid-air plant of 2 litre per hour capacity is installed in the laboratory and has proved of inestimate value in high vacuum work.

Very exact measurements of the spectra (3 metre-Runge-Paschen grating) of bromine excited by electrodeless discharge are being carried out and will be presently published.

Work on the hyperfine structures of the spark lines of antimony and cadmium is in progress. For these experiments a carbon hollow cathode fed with a current of up to one ampere is being used. A quartz Fabry-Perot interferometer in conjunction

with a quartz spectrograph and a suitable quartz-fluorite achromat are employed for the purpose. Considerable progress has been made and detailed results will be available shortly.

For the study of the Raman effect in liquids and solutions a modified appratus developed in the laboratory and described elsewhere* is being used with a Leiss spectrograph. Raman spectra are also being studied for solids at liquid air temperatures. A simple technique has been developed for this purpose.

Nuclear physics (theoretical) -Penetration coefficient for deuterons leading to (d-p) reactions differs from that of alpha particles because the occurrence of the (d-p) reaction does not necessarily imply a complete entry of the deuteron into the Coulomb potential barrier of the nucleus. All that is essential for this type of reaction is that the neutron of the deuteron should reach the nucleus. And on account of the large size and small binding energy of the deuteron this can happen without the proton also reaching the nucleus. It is now shown that the picture of 'partial entry' is applicable only when the incident energy is less than a certain maximum: this maximum corresponding to the state when the proton also reaches the nucleus. When the energy of the incident deuterons is greater than this maximum, Gamow's theory of complete entry applies.

II.

Allahabad University

Organic chemical research in the Allahabad University is being carried on in many interesting subjects and lines, but the following are amongst the important.

Cause of Colour Investigations on the cause of colour of the organic and inorganic salts of diphenylvioluric acid have revealed a relation with their chemical constitutions. From a study of the absorption spectra and hydrolysis constants of the inorganic and organic salts, the intensity of the colour of the salts has been found to be proportional to the strength of the basic character of the base, as previously found in the case of the corresponding salts of violuric acid. Further study of the absorption spectra of the salts of the newly synthesised higher homologues and analogues of diphenylvioluric acid indicates that the effect of additional load on the molecule of the substance is to produce still further intensification of colour as expected from theoretical considerations, the greater effect being produced by substituents in meta positions followed by those in the para.

Dyestuffs -From chrysene, which is a rare hydrocarbon of coal tar, *via* quinone, chrysoquinone, new dyestuffs by condensation with aromatic amines and diamines have been prepared. Interesting anilino compounds have also been obtained from chrysoquinone possessing good tinctorial properties by treatment of the substance with bromine under various conditions, followed by aniline in presence of copper powder. The dyestuffs obtained in this way dye cotton and wool both from the hydrosulphite vat as well as from an acid bath in various shades ranging from yellow to reddish violet. The shades thus obtained are fast to light and washing.

Isonitroso-diphenyl thio-barbituric acid has been prepared for the first time by the action of nitrous acid on 1:3 diphenyl-thio-barbituric acid, prepared in its turn by the action of diphenylthiourea on malonic acid in presence of acetyl chloride. The transition of colour on treatment with alkalies or organic bases being sufficiently strong and sharp for the substance, it may be used as an excellent indicator. The change of colour from orange to blue or green has been shown from theoratical considerations to be due to a fundamental change in the constitution of molecule from an oximino-ketonic to a nitroso enolic structure.

The phenomena of fluorescence Works in the laboratory have shown that the fluorescence of organic compounds is mainly due to impurities, and well known fluorescent substances of the type, quinine, resacetophenone, anthracene etc., lose their fluorescence completely on exhaustive purification.

Rare metals in organic synthesis—Comparatively rare metals like chromium, molybdenum, tungsten, cerium, uranium, thorium and the like have been used for the first time in this laboratory and many

* *Journal of Scientific Instruments* Vol. VIII, p. 258 and Vol. IX p. 324.

difficultly available compounds which could not be synthesised by the ordinary methods have been obtained in this way.

Natural organic colouring matter—The colouring matter of *Mehdi* or *Hena* (Lawsonia alba) which is so widely used by ladies in our country for colouring their finger nails and in Europe as a constituent of hair washes for auburn hair has been isolated in a pure crystalline condition and its constitution has been found to correspond to 2-hydroxy-1:4-napthaquinone, which has also been synthetically prepared and identified with the natural colouring matter. Besides, the colouring matters of *Harsingar* (Nyctanthus arbortristis), *Saffron* (Crocus sativus), *Dhak* or *Palas* (Butea fondosa), *Rhori* (Malotus philipinensis), *Bhaberang* (Embelia ribes), *Chita* (Plumbago zylicica), *Ghaneri* (Lantana camera), *Haldu* (Adina cordifolia), *Padouk* (Pterocarpus dalbergad) etc., have been investigated, isolated in a pure crystalline condition and their constitution determined.

Indian Medicinal plants—In the study of Indian medicinal plants, alkaloids from Fumaria officinalis, Solanum xanthocarpum, Abrus precatorius, Laganeria vulgaria, Beerhavia diffusia, Alangium lamarki etc., glucosides from Thevatia nerifolia, Blepharis edulis, Nerium odorum, Glycosmis pentaphylla, Caesalpinia bonducella etc., lactones from Aegle marmelos, Cinchcrium intybus, Citrullus colocynthis, Cleome pentaphylla, etc., sterols from Hygrophylla spinosa, Solanum xantrocarpum, Plumbago ovata, Blepharis edulis, etc., and interesting hydrocarbones from Indigofera enneaphylla, Thevatia berifolia, Cuscuta reflex etc., have been isolated and properties studied. Many of the active principles isolated from these medicinal plants have also been pharmacologically examined and adopted for medicine.

Essential oils—Essential oils are widely used in perfumery, flavouring matters, cosmetics and medicine. The essential oil of *Tulsi* (Ocimum sanctum) has been shown to consist of over 70 per cent of eugenol, a valuable product which is usually obtained from the oil of cloves. Similarly, the essential oil of *Mamri* (Xanthoxy alatum) has been shown to consist of nearly 68 per cent of citral, which is the active principle of lemon grass oil and is an important constituent of modern perfumes. The essential oil of *Tejbal* has similarly been shown to consist of a large proportion of linaool, which is the active principle of oil of lavender, and as such has tremendous scope for utilisation in high class perfumery.

Industrial organic research—Special oils from the various seed resources of the U. P. such as, Cassia occidentalis, Crotolaria medicagenea, Lagenaria vulgaris, Cleome pentaphylla etc., have been carefully examined and analysed with a view to their possible utilisation in industry. Fusel oils from several patent still distilleries have been examined and are under analysis for utilisation as solvents for varnishes and enamels. The fibre resources of the province are being systematically studied for their possible utilisation in paper and rayon industries.

Book Review

Background to Modern Science Ten lectures at Cambridge arranged by the History of Science Committee, 1936. *Edited by Joseph Needham and Walter Pagel.* (*Cambridge University Press, 1938*). *Pp. xii + 244. Price 7s. 6d.*

This course of lectures is the outcome of the need felt by a group of scholars and scientists in Cambridge that too little attention had been paid during the recent period of great development of research and teaching, extending from the latter half of nineteenth century to the present times, to the study of the history of science and technology. Through science man has reached a reliable knowledge of the properties of the world in which he finds himself; through applied science or technique he has succeeded in making himself even more indpendent of his environment. History of science is an important element in the history of civilization. A committee was formed to provide courses of lectures on the history of science. The first act of the committee to arrange an inaugural course of lectures on the modern period, 1895-1935, by scientific investigators who had themselves made fundamental contributions to science during that period. The lecturers included men like Rutherford, Bragg, Aston, Eddington, Nuttall, Ryle, Punnett and J. B. S. Haldane and the subjects dealt with are Physics, Crystal Physics, Atomic Theory, Astronomy, Physiology and Pathology, Genetics, Evolution Theory, Parasitology and Tropical Medicine. Two introductory lectures by F. M. Cornford on 'Greek Natural Philosophy' and by W. C. Dampier on 'From Aristotle to Galileo', give a connected account of the historical development of the ideas from which modern science has evolved. The book is very interesting to read and can be strongly recommended to students of science and to the intelligent general reader who is interested in the recent developments of science. Rutherford's account of the experiments of Geiger and Marsden which stimulated him to the formulation of his nuclear theory of the atom is an interesting record of the mental process which led to the development of a new scientific concept. Of great interest are also accounts by Bragg, Aston and Eddington of the discoveries with which their names are associated.

The following quotations will give an idea of the spirit in which these lectures have been conceived.

Rutherford " I have tried to show that it is not in the nature of things for any man to make a sudden violent discovery; science goes step by step and every man depends on the work of his predecessors. When you hear of a sudden unexpected discovery you can always be sure that it has grown up by the influence of one man upon another, and it is this mutual influence which makes the enormous possibility of scientific advance."

Eddington—" I have told you, as best as I can, something of what we have learnt in the last forty years. I will end by expressing a hope not unmingled by doubt that not too much of what I have been saying will be upset in the next forty years."

Punnett speaking of the development of the theory of evolution. 'The idea of yesterday has become the illusion of today; today's idea may become the illusion of tomorrow. 'For' says Meredith 'the mastery of an event lasteth among man the space of one cycle of years, and after that a fresh illusion springeth to befool mankind.' Doubtless many masters of the event will follow after Darwin and Bateson in wielding the sword of Aklis, and through the dispelling of illusion after illusion, mankind may eventually encounter the ultimate

residue, perhaps the ultimate of all illusions, which we optimistically designate as truth."

D. M. B.

District Development Scheme Economic Progress by Forced Marches *by Sir M. Visvesvaraya. (The Bangalore Press, Bangalore). Pp. 63. Price not stated.*

Sir M. Visvesvaraya's interest in economic development of India has been testified in more than one way through his publications and practical handling of related projects. When India, under the flush of enthusiasm accompanying the new constitutional experiment, is busy considering various schemes of socio-economic reconstruction, he has come out with another of his suggestive brochures, which is at present under review.

In his foreword, the writer draws attention to certain basic facts. The present production in an Indian district falls many times short of what it would have been, "if inhabited and exploited by a progressive vigorous modern people". This would be accounted for by the latter's wiser choice of occupations, their superior organising ability, forethought, courage and corporate spirit. In broad outlines the scheme seeks to stimulate production by means of (*a*) expansion of industries, (*b*) mass education, (*c*) use of labour-saving tools and machinery, and (*d*) a working knowledge of economics and the social background. It is needless to point out that underlying the proposals is the desire to usher in radical changes in the Indian attitude towards life. It seeks an immediate raising of standard of life and repudiates the Gandhian approach to economic problems.

The immediate aim is to so multiply goods and services for consumption as to double the income, within, at the utmost, a decade. Rightly does Visvesvaraya point out that with a per capita income of about one tenth of the average in western Europe, India is hardly suited for slow long-range programmes. Idleness, mental and physical, is too common a malady, public imagination and ambition has also degenerated into apathy. The writer wants every Provincial Government to select a district for the purpose of an intensive drive. "The districts should be consulted and offers invited to work the scheme. The district finally chosen should be one in which an appreciable number of influential public workers come forward to pull their weight, and the masses of the rural population are willing to tax themselves to the small extent needed to supplement the Government grant."

The writer has drawn out details of the organisation to be set up, the requisite occupational and production survey, the cost of the scheme and a concrete programme. With a whirlwind campaign to force up production and maintain at any cost a minimum approved standard of living, "there is no reason why under favourable conditions the same population should not increase its income say, fivefold, within a generation."

Among the aids to development suggested are (*a*) extension of banking facilities, based on the use by Government of its own credit to keep large sums of money in circulation in the district selected; (*b*) maintenance of reliable statistics, (*c*) tariff protection, (*d*) mass education, and (*e*) development of local travel agencies as an aid to promote inter-communication and commercial intercourse. Several of these, however, would not be within the competence of Provincial Governments.

The brochure deserves the most serious attention of Ministers, public men and social service workers.

B. N. B.

Insects of Citrus and other Subtropical Fruits *by Henry J. Quayle, Professor of Entomology in the University of California. (New York Comstock Publishing Company, Inc. Ithaca, 1938). Pp. v + with 377 text-figures.*

In this book is provided a detailed knowledge of the major insects and mites that attack citrus fruit trees of subtropical countries. There is also given a chapter on the rodents, mematodes and snails that attack these plants. In the introduction, maps of the world are outlined showing he chief citrus areas of the world and the important citrus areas of California. Food plants and climate are the two important factors that govern insect distribution. Commercial citrus culure is more or less

confined to a fairly narrow subtropical belt above and below the equator. The subtropical fruit areas of the world fall under two general types of climate, humid and semi-arid. The insect species of the semi-arid regions are more or less the same, and there are certain species which are characteristic of the humid regions only. The effect of climate on the distribution of the subtropical fruit insects is discussed. Several species and kinds of fruits grouped under the genus *Citrus* with their more important insect pests and the countries in which they are grown are dealt with. A key to the principal citrus fruit insects and mites in the United States is given.

The citrus rust mite, *Phyllocoptes oleivorus*, is an important pest of citrus trees in Florida and other Gulf States, while the citrus red mite, *Paratetranychus citri*, occupies a similar position in California. The economic importance of these mites, their injury to the foliage and fruits, their life history, seasonal history and control are described. The six spotted mite, *Tetranychus sexmaculatus*, is the most common mite on citrus trees in the Gulf States. This mite feeds on very definite areas on the under side of the leaf usually along the mid-rib or larger veins. A distinct depression is formed where the colony of the mites has its headquarters. The enemies of mites belong to the orders of *Insecta*, *Neuroptera*, *Thysanoptera*, *Coleoptera*, *Diptera*, *Hymenoptera* and *Arachnida*. Fumigation is known often to cause an increase in the number of the citrus red mite because their enemies are destroyed by such treatment, which has hardly any effect on the mites. Spraying with oil also kills many of the enemies, but it is effective in checking the mites.

A key to the important species of adult thrips (*Thysanoptera*) attacking citrus is provided. *Scirtothrips citri* is one of the most important citrus pests of the southwestern region of the U. S. A. It prefers the Navel orange to the Valencia. The south African citrus thrips, *Scirtothrips aurantii* is an important citrus pest in Rhodesia and parts of the Union of South Africa, particularly in Transvaal. An account of the life history of these thrips and the injury by them to the plants is given. Aphids form one of the well known pests of citrus plants. The cotton or melon aphid is a common pest of melons, squashes and cucumber and of cotton. It attacks the young growth of trees, causing the leaves to become badly curled and distorted and has the usual aphid life history. Aphids have a large number of insect enemies, both predators and parasites. One of the most important groups of predatory insects is the ladybird beetles or *Coccinellids*. The larva of the Chinese ladybird beetle, *Scymnus terminatus*, has been found to consume as many as 200 young aphids per day, and about an equal number is consumed by the adult. Some important species of syrphid flies attacking aphids in California and Florida are mentioned. The most important parasite of citrus aphids ,or aphids in general, in California is *Lysiphlebus testaceipes*. Some fungus diseases are also destructive to aphids. The important constituent in aphid control is the alkaloid of tobacco, commonly known as nicotine, which is combined in a dust or spray, the formulae for which are given. In California for the combined treatment of the citrus red mite and aphids in the spring, the formula recommended by Dodds is given.

The scale insects and mealybugs (superfamily-*Coccoidea*) form the greatest number of insect species that attack subtropical fruits. The long, delicate, thread-like mouth parts of the coccids, which are able to penetrate woody tissue, are of importance to the economic entomologist. The mechanism of their operation and how the liquid food from the plant is taken in are described. The cottony cushion scale, *Icerya purchasi*, a native of Australia became once a menace to the citrus industry in California. It has a wide distribution, occurring in Australia, Brazil, New Zealand, Azores, Ceylon, Chile, Hawaii, Italy, Dalmatia, Spain, South Africa, Mexico, Southern United States, Portugal, St. Helena, Mauritius, France, Fiji, Asia Minor and Japan. Its life history is described. The beetle *Vedalia cardinalis*, both the larvae and the adult, now known as *Rodolia cardinalis*, feed on the cottony cushion scale. This beetle soon after its introduction into California from Australia increased very rapidly and the orchards became practically free from the ravages of this dreadful pest. The control by *Vedalia* has been repeated in Florida, Texas, Spain and Italy. The black scale, *Saissetia oleae*

is another pest, which has a wide range of host plants. It is widely distributed over the tropical and subtropical countries of the world and is one of the most important citrus insects in California. It is also common on citrus in the coastal districts of Spain. The extraction of sap from the tree by the black scale provides a medium through its excretion for the growth of the sooty mold fungus, *Meliola camelliae*, which may completely cover all the upper surface of the tree. A complete account of its life history, parasites and predators is given. Orange pulvinaria, *Pulvinaria aurantii*, is a serious pest of citrus in Japan. It also occurs on curya and tea plant. California red scale, *Aonidiella aurantii*, is the most important pest of citrus in Australia, California, South Africa and the north western part of Mexico. Various other scales parasitic on citrus and developing as serious pests are properly treated in the book. The mealybugs, such as *Pseudococcus citri*, Citophilus mealybug, *Pseudococcus gahani*, grape mealybug, *Pseudococcus longispinus* are also important pests of citrus in many parts of the world. They extact juice from the plant and excrete a large quantity of honey dew in which the sooty mold fungus grows. This fungus causes a black covering on the foliage and fruit. The mealybugs are attacked by a large number of insect enemies. Their soft bodies, inactivity and exposure on the plant are favourable for both parasite and predator attack. The mass production of the mealybug destroyer, *Cryptolaemus montrouzieri* on potato sprouts in confinement has been found to be of practical value for the control of the citrophilus mealybug in citrus orchards in California.

There are only three bugs recorded to cause serious pests on citrus. The large horned citrus bug, *Biprorulus bibax*, is an important citrus pest in Queensland on the native kumquat or desert lime and the finger lime. The bronze orange bug, *Rhoecocoris sulciventris*, is a pest of orange in Queensland and New South Wales. *Rhynchocoris humeralis* is of much economic importance in parts of China and India. At Canton it attacks the varieties of orange but not the lemon or pomelo.

Among the beetles the citrus bark borer, *Agrilus occipitalis* is one of the serious pests in Philippines and *Melanauster chinensis* in Japan. The larvae of Fuller's rose weevil, *Pantomorus godmani* live usually on the roots of the citrus tree. *Batocera rubus*, which is a fairly common citrus pest in India, is also recorded from West Indies, Africa and Ceylon.

The caterpillar of the orange dog, *Papilio cresphontes* is one of the commonest and most destructive of the butterflies attacking citrus in Florida. It feeds greedily on foliage and a young tree may be entirely deprived of its leaves by two or three individuals in a few days. The caterpillars of *Papilio demoleus* occupy the same position in India, though it is not pointedly noted in the book. The species of *Papilio* recorded from citrus in India as mentioned in the book according to H. Pruthi in addition to the last named speceis are *P. polytes*, *P. memnon*, *P. helenus* and *P. polymnestor*. The moth borer, *Citripestis sagittiferella*, is destructive to the grapefruit, orange, lemon and lime at the lower elevations in Malaya and the Dutch East Indies. The orange tortrix, *Argyrotaenia* (*Tortrix*) *citrana*, is an important pest of the orange in certain parts of California. The citrus rind borer, *Prays endocarpa*, is strictly a fruit feeder. The citrus leaf miner, *Phyllocnistis citrella*, occurs on nearly every tree in greater or smaller numbers in the Far East. The eggs are laid near the mid-rib on the lower side of the leaf. The young larva, as soon as it emerges, enters the leaf and begins the formation of the characteristic serpentine mine.

Fruit flies (family-*Trypaneidae*) includes some of the most important pests. The adults are often found on the foliage or flowers, while the larvae live on fruits, leaves, stem and other parts of growing plants. The Mediterranean fruit fly, *Ceratitis capitata* is well known for its great range of hosts and wide distribution. The growing of peaches is restricted in many areas on account of this fly. In Egypt and Palestine the oanges suffer from its attacks. The most effective method of control consists in the use of poisonous bait sprays according to definite formulae, which as applied in South Africa and Australia, are repeated every seven days while the crop is susceptible and when the adult fly is active.

The chapters on fumigation, and spraying and dusting are as complete as can be possibly expected.

BOOK REVIEW

The early history of fumigation with illustrations showing the various methods and fumigators in use hardly leaves anything of account. In our opinion as it is doubtful whether fumigation, which causes a certain amount of injury to the plant should be recommended, such an exhaustive account of the subject is probably unnecessary except for a small number of experts. It is evident that injury to the tree may result if the fumigation dose is too heavy. In certain conditions a low dosage may also cause as much injury. Though the dosage of fumigation as practised at present is uniform, other factors are more important in causing injury than excessive quantity of cyanide.

The book is a very useful contribution to the subject both for a specialist and a student of applied entomology,. To horticulturists as well as to those for whom citrus culture is of commercial value, we hope that it will prove of equal use.

H. R. M.

THE GERMAN PRIMER FOR SCIENCE STUDENTS *by Haragopal Biswas, M,Sc. (University of Calcutta, 1938). Pp. 255. Price Rs. 2/- only.*

Generally Indian students are much handicapped in their advanced studies in scientific subjects owing to their ignorance of the German language. In fact, the vast majority of important text books of science written in German language and the great output of scientific researches published in German journals undoubtedly go to show that science and the German language are inseparable.

Unfortunately there are not many books available in India, which may be of help for our science students to learn German. Mr. Biswas's book is a great enterprise in this direction. He has learnt German by himself and, therefore, has been able to appeiate and remove the difficulties with which a beginner is generally embarrassed. Mr. Biswas deserves congratulation for laying the fruits of his struggle and experience in the book under review for the benefit of the students in this country.

In the words of the author, 'the arrangements and graduation of lessons in the book, the wide range of interests from which the subject matter has been gleaned, have all been planned to confer on the beginner the maximum benefit with the minimum expenditure of time and energy.' In the first 59 pages he has given the essential rules of grammar in a lucid style. The next 50 pages have been devoted to the literature section where the necessary conversational phrases, the important proverbs, characteristic German humorous passages, art of letter writting etc., are represented very creditably. Some historical passages from Indian history, the famous literary passages from Tagore, Kalidas, Schiller and Goethe and biographical sketches of some famous scientists are also given. This selection is really praiseworthy.

In the next 100 pages he has dealt wiht the scientific subjects. In this section he has given the names of the ordinary laboratory apparatus, terms that frequently occur in scientific literature, short passages and some typical topics of science. The last 50 pages contain a useful vocabulary for nouns and verbs which are generally found in scientific literature.

The book is not, however, completely free from defects. Some pronunciations given in the beginning of the book do not seem to be correctly represented. Further, in additin to some mistakes here and there the author's style of German does not appear to be very bapppy. There are also some funny passages in the book as for example, in page 84 while giving a description of the city of Calcutta, he writes: 'Calcutta is India's London. The whtie town of the Europeans offers a grand view, full of spendour, moderness and taste and totally opposite to this is the black town where the Hindus live.' The same wrong and queer idea about us is also prevalent in Germany where the reviewer had often been sarcasticaly asked similar questions by even the educated German people. On enquiry he found such passage in German text books on geography for children. It pains the riviewer to see its repetition in a book written by his own countryman.

These defects, however, should not affect the merit of the book. It can be recommended to the students of science, who are keen to learn German in India.

R. C. M.

LETTERS TO THE EDITOR

[*The Editor is not responsible for the views expressed in the Letters.*]

Some Old Sites in Palanpur State

About a mile from the town of Palanpur on the road to Jagana is a site scattered over with very small pieces of pottery. It is known as Gohri because of its proximity to a tank of same name. The old city of Palanpur is believed to have been situated on this site. I was told by a farmer, working in the field near by, that his old father had told him that thirty or forty years ago somebody had excavated a portion of the site and had discovered large earthenware jars. I searched the site for two days and found a few pieces of archaeological interest, illustrated in Pl. 1. The five upper pieces are cores or flakes of stones. The first and fourth are cores of flinty material and the third a fine flake-chip of green jasper. The middle piece in the lower half is a piece of conch shell and the first and the third objects are pieces of bangles of crude glass. These microlithic finds are similar

Pl. 1

to those known from some sites in Kathiawar, described and figured by R. Bruce Foote in his *Indian Prehistoric and Protohistoric Antiquities*. I got a few pits dug but nothing turned up.

As old Deesa was reported to be an ancient site I paid a visit to it. There I came across quantities of broken pieces

Pl. 2

of glazed pottery, some of which are illustrated in Pl. 2. It is difficult to fix their chronology but they are evidently post-Mahommedan.

About 14 miles to the southwest of Deesa there is the village of Bhiladi adjoining which is a large site scattered over with pieces of pottery and generally believed by the people to be the old town of Bhiladi. The pottery pieces, though very small, were clearly of the same glazed type as those of old Deesa. I procured a brick which was dug out from the site by a villager and was used by him. It is rather of curious measurements: 13″×13″ by 1·5″ to 1·8″. It seems to have been intended as a flooring tile.

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G. S. Ghurye.

Separation of the coagulating principle from the other active substances present in venom of vipera Russelli

Attempts have been made by different authors[1] to separate the blood coagulating principle from the other constituents present in snake venom. These attempts have so far met

with little success. We have also been investigating for some time the possibility of separation of the blood coagulating principle present in the venom of Russell's Viper. Only recently we have succeeded in separating this substance from the neurotoxin and the haemorrhagin. The following procedure was adopted by us.

To 0·1 gm of Russell's Viper venom, dissolved in 10 c.c. of physiological saline, 5 gm. of anhydrous magnesium sulphate was gradually added while stirring, the mixture being simultaneously cooled. It was then left for 30 minutes inside a frigidiare at 6°c. It was afterwards filtered under suction using Whatmann filter paper No. 50. The precipitate was removed and dissolved in 10 c.c. of physiological saline. This solution contained the whole of the coagulating principle mixed with 16–18% of neurotoxin. It was then reprecipitated using 5 gms. of magnesium sulphate. The second precipitate contained 90% of the haemostatic principle and 10% of the neurotoxin of the original venom. The coagulating principle was further purified by treatment with silicic acid gel which adsorbed the neurotoxin in preference to the haemostatic principle. The supernatant liquid after treatment with silicic acid gel was found to contain 90% coagulating principle and 5—5·5% neurotoxin.

This solution was then subjected to cataphoretic experiment in a three chambered cell, the chambers being separated from each other by cella or membrane filter of medium porosity. The solution containing the coagulating principle was adjusted at pH 5·0 and was placed in the middle chamber of the cataphoretic cell. A current of 10 milli amperes was passed for 2 hours. After this period the contents of the various chambers were tested and the anode chamber was found to contain the major portion of the coagulating principle free from neurotoxin and haemorrhagin.

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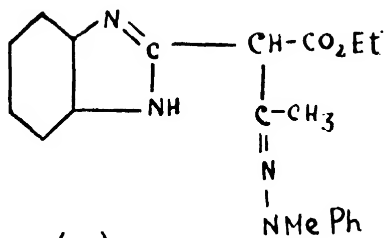
S. S. De.
P. C. Ray.

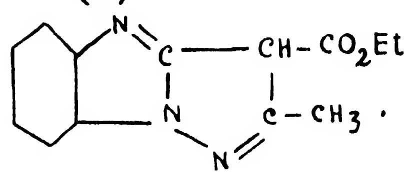
[1] Ganguly S. N. and Malkana M. T., *Ind. Jour. Med. Res.* 23, 997, 1936.

Pyrazolinobenziminazoles

In recent years search has been made for antimalarials in iminazole derivatives.[1] In view of the antipyretic properties of some pyrazolone compounds, a pyrazolinobenziminazole derivative has now been synthesised. When the compound (I), obtained by condensing 2-carbethoxyacetylmethylbenziminazole[2] with α methyl-α-phenylhydrazine, is heated with alcoholic hydrochloric acid, the pyrazolinobenziminazole derivative (II) (m. p. 216-217°) is obtained (Found: C, 64·53; H, 5·39; N, 17·46. $C_{13}H_{13}O_2N_3$ requires C, 64·2; H, 5·34; N, 17·28 per cent.); *picrate*, m. p. 182 183°. It is insoluble in alkali and hydrochloric acid, and does not form a hydrochloride. With concentrated sulphuric acid and alloxan, it gives a greenish blue colouration. With hydrazine hydrate it yields the *hydrazide* (m. p. 198 199° decomp.), which readily forms a hydrochloride.



(I)



(II)

It is, however, noted that the compound (II), in which there is a nitrogen atom common to two fused ring systems, is structurally related to pyridobenziminazole and quinolobenziminazole, recently sythesised by Morgan and Stewart.[3]

The authors' grateful thanks are due to Prof. P. C. Guha for his kind interest in this investigation.

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[3] *J. Chem. Soc.*, 1292, 1938.

The Isomers of 1-Carboxy -1-, -3-, and -2- methyl-cyclohexane -1- Succinic acids

In the April issue of Science and Culture (page 599), Nripendra Nath Chatterjee has written a letter which needs a reply. It may be pointed out, in this connection, that the paper published by Desai, Hunter and Sahariya[1] is a natural sequel to the work already started by Desai since 1930, and first published in 1932.[2] This work has been continued by him and his collaborators, and published in subsequent papers.[3] The recent publication (*loc. cit.*) incorporates the data which were with the authors two years ago and a preliminary note on this had appeared in *Nature* in 1937.[4] The question of overlooking the "important statement" therefore does not arise.

The isomers in question were already isolated by Desai and collaborators meanwhile when Chatterjee published his paper containing the statement " no definite isomers of the acids have been isolated and experiments are in progress to separate them ".

In conclusion, it may be pointed out that the investigations on the isomers of cyclohexane and its derivatives are being continued by Desai and collaborators, and that if Chatterjee were to continue work on these lines, it would be mere overlapping which is undersirable.

Department of Chemistry, R. D. Desai.
V. J. T. Institute,
Matunga,
Bombay, 18-4-39.

[1] *J. C. S.* 84, 1939.
[2] *J. C. S.* 1047, 1932.
[3] *J. C. S.* 416, 1159, 1676, 1936.; *Nature*, *138*, 548, 1936.
[4] *Nature*, *139*, 718, 1937.

The Isomers of 1-carboxy-1-, -3-, and 2-methylcyclohexane -1- Succinic acids

Dr Desai's reply to my letter[1] demands a rejoinder and I, therefore, like to record the following lines in response to his.

(*a*) The paper published by Desai in 1932[2] deals with the Formation and Stability of Spiro-compounds on the basis of the ' Valency deflexion hypothesis ' of Thorpe and Ingold, and not on the separation of the isomers of cyclohexane derivatives of open chain acids. My first paper in the line was published in 1935[3]. In 1936, however, Desai published papers[4] which did not overlap my line. The experiments recorded there were to verify Dr Khuda's claim on the isolation of the isomers of methyl cyclohexane 1 carboxylic 1- acetic acids, in 1931[5].

(*b*) It was after Desai's communication of a note in 1937[6] that the overlapping actually occurred. Unfortunately it was after the inclusion of my detailed paper[7] on the subject, in the proceedings of the Indian Chemical Society. Desai's communication, however, to the *Nature* did not contain any experimental data although he claimed to have separated the isomers.

(*c*) In his detailed paper[8] in the Journal of the Chemical Society in 1939, Desai has adopted the very same methods of preparation of the compounds described by the present author as early as 1936[9]. The reference to my work made by Desai in the said paper has been, I am afraid, a bit inadequate.

(*d*) It may be that Desai began his work earlier but the credit of prior publication goes to the present author. It is unfortunate that Desai would continue these works though he can not claim priority of publication.

Chemical Laboratory, Nripendra Nath Chatterjee.
University College of Science and Technology,
Calcutta, 8-5-39.

[1] SCIENCE AND CULTURE, *4*, 599, 1939.

[2] *J. C. S.*, 1047, 1932.

[3] SCIENCE AND CULTURE, *1*, 435, 1935; *J. Ind. Chem. Soc.* *13*, 536, 1936.

[4] *J. C. S.* 416, 1159, 1676, 1936; *Nature*, *138*, 548, 1936.

[5] *J. Ind. Chem. Soc.*, *8*, 277, 1931.

[6] *Nature*, *139*, 718, 1937.

[7] SCIENCE AND CULTURE, *1*, 788, 1936 and *J. Ind. Chem. Soc.* 127, 1937.

[8] *J. C. S.*, 84, 1939.

[9] *loc. cit.*

[No further correspondence on this subject will be published in these columns. *Ed. Sc. & Cul.*]

SUPPLEMENT

Indian Science News Association

Third Annual Meeting

The third annual general meeting of the Indian Science News Association was held at the University College of Science, Calcutta on the 21st August, 1938, at 4-45 P.M. On the proposal of Prof. S. P. Agharkar, Sj. Subhas Chandra Bose, President of the Indian National Congress, was voted to the chair.

The Secretary of the Association, Professor S. K. Mitra, in submitting the report for the period July, '37 to June, '38 reminded the audience that the Association started the journal *Science and Culture* more than three years ago with a view to awakening the interest of the public in the methods of application of science to national regeneration. During the year under review, a few of the subjects discussed editorially and in articles written by specialists were Cheap Electricity, River Problems, Industrial Organisation, Scientific Research Boards, Vernalisation, A new method of Agriculture discovered in Russia--which allows large tracts of hitherto uncultivated regions in Russia to grow food crops etc. It was a matter of regret that the section 'Science in Industry' in which were published articles on new methods of manufacture and new avenues of profit by way of application of the latest discoveries of science, from persons in Technological Institutions and Research Institutes, had not been able to create a lively and also profitable interest among the Industries of the country due to their all-absorbing concern for the economic issues. The high standard which the journal has reached is evident from the fact, that many scientists of international standing responded to our invitation to write for our journal. Such were Sir James H. Jeans, Sir Arthur Eddington, Dr F. W. Aston, Prof. F. K. Morris, Prof. H. J. Fleure etc. The Association received recurring grants from the Universities of Calcutta and Delhi, Indian Science Congress Association, Indian Association for the Cultivation of Science and Bengal Chemical & Pharmaceutical Works Ltd. It also received donations from private individuals and bodies like the Hon'ble Mr N. R. Sarker and the Burmah Oil Co., Ltd.

At the election of the Office-bearers and the members of the Council for the year 1938-1939 (July-June) the following gentlemen were unanimously voted to the Council:—

President:—Dr S. C. Law.

Vice-Presidents:—Sir U. N. Brahmachari; Dr Baini Prasad; Prof. M. N. Saha; Mr S. P. Mookerjee and Bt.-Col. R. N. Chopra.

Treasurer:- Prof. P. C. Mitter.

Secretaries:--Prof. S. K. Mitra and Prof. P. N. Ghosh.

Members: -Prof. P. R. Ray; Mr A. K. Chanda; Mr N. C. Ray; Mr H. P. Bhaumik; Lt. Col. A. C. Chatterji; Dr N. R. Dhar; Dr P. K. Ghosh; Dr M. Qudrat-i-Khuda; Dr B. S. Guha; Prof. N. R. Sen; Prof. J. N. Mukherjee; Prof. S. C. Mitra; Prof. S. P. Agharkar; Prof. B. B. Ray; Prof. H. K. Mookerjee; Prof. N. C. Nag; Mr B. N. Maitra; Dr D. S. Kothari; Prof. S. S. Bhatnagar and Prof. J. C. Ghosh.

The Board of Editors for the journal during the current year has been constituted with Profs. M. N. Saha, J. C. Ghosh, Dr A. C. Ukil and the two Secretaries.

A scheme for having a board of editorial co-operators was discussed, and adopted.

Prof. Meghnad Saha, in explaining the aims and objects of the Indian Science News Association, said that they were trying to bring to the notice of the public, in simple language, and by means of editorials in their journal, *Science and Culture*, the value of science to the country. The characteristic feature of this Journal is that we always try to present accurate and well-authenticated figures, which tend to create a realistic picture of the situation. This Journal was the first to point out that the production of work per capita in this country is nearly 20 times less than in European countries. Can any other argument point out more forcibly that the

present rate of work output must be multiplied ten times at least if we wish to have any decent standard of living for our masses. This Journal was the first to point out that the output of electricity is only 7 units per capita, and nearly 100 times less than in European countries. Can any other figure be more convincing that the development of natural resources in power has been extremely meagre? We pointed out that the number of museums in this country is nearly thousand times less than in a country like Sweden. Can any other argument be more convincing about the low standard of cultural level amongst the masses of this country?

Prof. Saha quoted an article contributed to *Science and Culture* by Mr Bose written in 1935 from Karlsbad in which he asked scientists and scientific investigators to come to the rescue of political workers in solving the various national problems. Prof. Saha said that the first problem raised by Mr Bose was whether Indian civilization was in the evening of its life or was it on the threshold of a new dawn. He did not want a sentimental but a scientific reply as to whether the awakening that was now witnessed was an organic growth from within, a new creation, or was it a mere response to the impact of the West, of the same character as the reflex of a muscle under stimulus. The second question of Mr Bose, said Prof. Saha, was what were the conditions essential for revivifying a civilization like the Indian that had begun to stagnate. The third question was whether for increasing the vitality of the Indian nation should they promote inter-caste or intra-caste marriages, or whether exogamic marriages were more conducive to the welfare of a people or endogamic.

Till quite recently, wrote Mr Bose in his article, scientific men would have been inclined to say unhesitatingly that India would do well to remove artificial restrictions on marriage. But the new racial theory of the Nazis had made them all ponder over the problem once again. If the Nazi theory was scientifically wrong and if exogamic marriages were really good for the race then Mr Bose thought that it was high time to give a scientific reply to the claims of the Nazi race-theorist.

Prof. Saha also referred to other questions relating to common script, common diet and common dress which Mr Bose raised in his article.

Although the article, said Prof. Saha, was contributed by Mr Bose as early as 1935, most of his questions still remained unanswered and he would try as briefly as he could to reply a few of them.

"To the question whether Indian civilization was in the evening of its life or was it on the threshold of a new dawn my answer," said Prof. Saha "is that if we accept the theory of Flinders Petrie or Spengler there is periodicity of 1500 years in a nation's life. Our lowest level was reached about 1200 A.D. and now we are probably recovering from a long winter of decadence to a spring of new life."

"But" said Prof. Saha "the movements of new life must be properly guided, what is wanted is a new philosophy of life which will renew the springs of our civilization and culture."

This, Prof. Saha believed, would contain the answer to the second question of Mr. Bose.

To his third question about the artificial restrictions on marriage in India, Prof. Saha first referred to the Nazi race-theory.

He observed, "The idea of national and racial superiority is no new phenomenon. Every nation, when it achieves greatness, looks down upon others less fortunate, and tries to find out a cause for its greatness. When Greece became great in the third century B.C., Aristotle, egovistically asked himself: Why the Hellenic nation is the greatest people in the world and proceeded to find out an answer. The cause according to him was meteorological; the northern barbarians (he meant the ancestors of the West European nations) live in such a cold climate that all their energy is spent in fighting Nature. The southerners (Arabs, Jews, etc) live in such hot countries, that they have no energy left to turn to higher things. Greece, he said, has the ideal climate, and the ideal people. Hence, he concluded, Greeks would continue to be the greatest people in the world."

But historical events entirely falsified Aristotle's predictions. Greece practically contributed nothing to civilisation since the 5th century A.D., while the despised barbarians, to whom Aristotle referred in such contemptuous terms, became creators of great civilisations shortly afterwards. In the sixth century A.D., the Arabs created a civilisation of unique type which flourished in full vigour till about the fourteenth. Contribution of Islam to Science and Literature has been simply marvellous. The Northern barbarians of Aristotle created the great West-European civilisation which dominates modern times. The meteorological theory of Aristotle, therefore, completely failed.

The Nazi race theory about the purity of the Aryan race looked, he observed, very much like the theory of *Varnasram Dharma* in this country, which

crystallized into shape about the 2nd century A.D. (time of Manusmriti), when some classes were segregated from others partly on the basis of racial superiority, partly on the basis of supposed superiority of certain profession to others. The result of this theory was the race which peopled India about 1200 A.D. who went down so ignominiously before the Turkish invaders; the theory, which still persists, and has unfortunately set India on its long winter of decadence.

Physical measurements of the Negroes and their brain power showed that they were in no way inferior to the white men and who could foretell that the Negroes of Africa would not be the pioneers of a new and vigorous civilization a few hundred years hence.

Question About Future

"May I put some questions to Mr Bose?" said Prof. Saha in conclusion. "May I enquire whether the India of future is going to revive the philosophy of village life, of bullock cart, thereby perpetuating servitude, or is she going to be a modern industrialized nation which having developed all her natural resources will solve the problem of poverty, ignorance and defence and will take an honoured place in the comity of nations and begin a new cycle in civilization?"

"If the Congress High Command," said he further "decides on a policy of industrilisation, are they going to set up a rationalized scheme of industrialisation and establish a National Research Council and mobilize the scientific intelligentsia of the country? I put the question because the Congress has come into power in several provinces and because there is a great confusion of ideas regarding the future industrialisation of India."

"Is India," said Prof. Saha, "going to be one nation or going to be divided into a patchwork of ill-defined provinces and states and communities separated by a babel of tongues and sentiments and artificial political restrictions? We find indications of this in every province of India to-day."

The address of the Congress President is printed separately (Vide pp. 139-141).

Mr G. S. Dutt, I.C.S. in proposing a hearty vote of thanks to the president recalled the other occasions when he came in touch with the Congress President in his official capacity. But at the present moment he stood there as an Indian to offer him homage, who, still young in years, had made his life so noble. He urged for reviving our ancient heritage and culture and opined that in consonance with popularization of science, which the Association is doing through the journal, a synthesis between Science, Culture and Politics should be devised.

At the close of the meeting the guests were treated to tea and light refreshments.

Publications Received

LUCKNOW UNIVERSITY STUDIES

PARASITIC WORMS AND DISEASES: LECTURES ON CERTAIN ASPECTS OF HELMINTHOLOGY, by Dr. G. S. Thapar, M. Sc., Ph.D.

SALTATION IN FUNGI, by Dr. S. N. Das Gupta, M.Sc., Ph.D., D.I.C.

LIESEGANG RINGS AND INFLUENCE OF MEDIA ON THEIR FORMATION, by Dr. A. C. Chatterji, D.Sc.

RECENT ADVANCES IN INDIAN PALAEOBOTANY, by Dr. B. Sahni, M.A., Sc.D., D.Sc., F.R.S., F.G.S., F.A.S.B.

PHOTOCHEMICAL PROCESSES, by Prof. P. S. MacMahon, M.Sc., B.Sc., F.I.C.

NITROGEN FIXATION AND ALKALI SOIL RECLAMATION, by Prof. N. R. Dhar, D.Sc., I.E.S.

THE GENERAL FIELD THEORY OF SCHOUTEN AND VAN DANTZIG, by Prof. N. G. Shabde, D.Sc.

THE THEORY AND CONSTRUCTION OF NON-DIFFERENTIABLE FUNCTIONS, by Dr. A. N. Singh.

ANNUAL REPORT (1937-38) OF THE INDIAN LAC RESEARCH INSTITUTE, RANCHI.

THIRD REPORT (1934-47) OF THE ROYAL INSTITUTE OF SCIENCE, BOMBAY.

REPORT (1936-37) OF THE WORK OF EDUCATION DEPARTMENT, HIGH COMMISSIONER FOR INDIA, LONDON.

REPORT OF THE LEAGUE OF NATIONS. Economic Committee on Preliminary investigations in to measures of a national or international character for raising the standards of living.

YEAR BOOK OF ROYAL ASIATIC SOCIETY OF BENGAL, Vol. II, 1936.

TABLES OF FUNCTIONS, by Dr. Eugene Jahnke and Fritz Emde. (G. Teubner, Leipzig).

Mathematical and Physical Sciences

Logic and Probability in Physics

—C. G. Darwin

AFTER the great loss suffered by England, nay, by the whole world, in the death of Lord Rutherford, it is inconceivable that one can do full justice to an address on Physical Science without mentioning him and his qualities. Like many of the modern physicists of repute I had the good fortune to serve in his labroatory in Manchester. From personal experience and from some of the interesting episodes we can form an estimate of the general traits of his character. I remember the occasion of a Sunday evening supper when he told us about the discovery of the nucleus that had arisen out of investigations into the scattering of α-particles in a sheet of good foil, and I remember being astonished at the use he could make of the vague recollections of what he had learnt in school about the hyperbola. It was subjected to various criticisms at the outset, but Rutherford got it right. It was a process I have heard described by saying that if Rutherford went into a chemical laboratory for a reagent he would somehow always go to the right bottle even if there were no labels. Of his later work, disintegration and so on, I will not speak, but only refer to one characteristic he showed in it. This was his capacity for changing his methods. When we try to assess the qualities of Lord Rutherford it would be difficult to classify him under a dichotomy of qualities for great men of science. For, he had that singular quality of being prepared for anything, of making each discovery fit on to the last and suggest the next.

In going over to the general subject of the address—Logic and Probability in Physics—I will only add that the life and work of Rutherford is the best possible text I could choose for the kind of view which I want to put before you. Recent scientific history has revealed a deep schism between the professional philosophers and the scientists, and this schism is worthy of examination. The position stands thus: There is a notable contrast between the way we think about things and the way we ought to think about them. We have set up as an ideal form of reasoning the formal logic which has held the field since the days of Aristotle. We rarely conform to this ideal. In as much as the old logic was devised for a world that was thought to have hard outlines, and that now the new mechanics have shown that the outlines are not hard, the method of reasoning must be changed. The key to the modification has already long been in our hands in the principle of probability, but whereas in the past constant attempts were made to fit this into the old system, the new mechanics suggests the possibility of a different synthesis.

Let us examine the position more critically. Why do we believe in the various theories that we are all agreed to accept? Once a theory has become well-established we usually get to work to find a system of axioms, postulates, indefinables and so on, from which it may be derived. For example, classical mechanics is based on Newton's Laws, or whatever system has been substituted for them by later criticism. The direct derivation of everything from an axiomatic basis has an attractive simplicity, but it tends to mak· us think that, we believe in the theory because of the axioms, whereas the axioms are only a convenient shorthand summarizing a wide field of information, and they are believed in merely because we believe in the theory.

Looking from a different angle, the 'logic' school of thought often takes recourse to the idea of a 'crucial experiment,' that which gives the answer 'yes' or 'no' to the whole theory. The most crucial experiment ever done was the Michelson-Morley experiment on ether-drift, which was made the basis of the whole Theory of Relativity. Michelson and Morley showed that to the limits of the precision of their apparatus there was no ether-drift. For some twenty years the Theory of Relativity grew enormously, based on this one experiment. Later Dayton Miller undertook the task of repeating the experiment of Michelson and Morley, with better equipment. He failed, however, to verify the exact vanishing of the ether-drift. The crucial experiment

thus failed. But nobody doubted relativity. There must, therefore, be some unknown sources of error which had upset Miller's work; and, as Miller was improving on Michelson, it follows that Michelson's work must have had two unknown sources of error which happened to cancel one another. In spite of the crucial experiment we do believe in relativity, on the ground that we see that it is a number of cumulative pieces of evidence which all fit together, and it is this cumulation, and not any one of its pieces, that makes us believe in the Theory of Relativity.

From such examples we conclude that an axiomatic basis, of the kind demanded for the operations of formal logic, is too narrow for the understanding of the physical world. Something wider is needed. It has been known also that this widening must be effected by the inclusion of "probability" in the narrow fold of the old logic. Attempts have been made, and are still being made, to bring probability into our system of reasoning, but these attempts have been always abortive. To any one who has thought seriously about the world, or, at any rate, has made an elementary study of mechanics, there is nothing more absolute than the "Law of Causality". By this it is meant that the future is completely contained in the present. Obviously there are examples that are true to this law—the orbits of planets and the paths of projectiles are such. But let us consider the tossing of a coin. We know that there is an even chance of heads or tails. Even though we could eliminate the human factor by taking recourse to a mechnical device of tossing the coin the results would not be otherwise. We try to explain away any question of probability: we do not feel that the fall of the coin is determined by chance, but we regard the uncertainty we observe as due to our ignorance of all the detailed causes. At any rate, we start prejudiced *against* probability and *in favour of* causality. But time is come when we are being freed from the absoluteness of causality.

The development of physics in the first quarter of the 20th century is the most remarkable period in the history of human thought. In 1901 Planck started the Quantum Theory. The work went rather deep into statistical theory, and there were many for long afterwards who were not convinced of its compelling force. And Planck knew that he had got something involving the revolutionary idea —the quantum. Einstein's theory of photo-electric effect, and of the ionization produced by X-rays, his theory of specific heats later improved by Debye, and Bohr's theory of spectra, all involved the same revolutionary idea. This was a conflict with the idea of the 19th century. Whereas Fresnel had *proved* that a beam of light was a system of waves Einstein was insisting on a composition of arrows! What does a rational being do when faced with two mutually contradictory ideas based on evidence? It was a nice test of the critical spirit and it revealed a wide divergence of choices. About the time when the Kinetic Theory of Gases was firmly established and the statistical theories of matter formed as essential part of physical education based on the works of Maxwell, Gibbs and Boltzmann, there was no common habit of thought on statistical lines. On the other hand, the laboratory workers, dealing with atoms and electrons, could not fail to be more impressed with the discontinuous phenomena and the beautiful way these could be explained by the quantum. Many accepted the Bohr orbits as a complete explanation of the hydrogen spectrum, ignoring the absurdity of supposing a sharp jump from one orbit to another for a train of waves shown by the spectroscope to be lasting for quite a long time. Bohr and other leaders recognized the difficulties and expected that a higher synthesis would emerge to fit everything in proper coherence.

As time went on the idea of quantum got stronger and stronger until about 1925, guided by the Correspondence Principle, things were moving towards a tentative theory of the refractive index, which suggested a break in the contradictions. Acting on a hint given by the theory of refraction, Heisenberg was led to the suggestion that the contradictions of the atomic theory would disappear if one adopted the idea of non-commutative algebra in dealing with the motions of electrons in an atom. Then the flood-gates opened and the whole New Quantum theory burst forth. A quite different approach was made independently by de Broglie and Schrödinger.

At first the work was of a formal kind,—a complete synthesis of the rival doctrines of particle and wave mechanics, but a very interesting point arose in connection with the discovery. In his first paper Heisenberg laid great stress on the idea of

building theory only on directly observable quantities. The electron's orbit is certainly not observable, much less the electric force which is the amplitude in the light-wave emitted by the atom. So he modified his theory to remedy the defect by means of the Uncertainty Principle. This Principle asserts that it is impossible simultaneously to measure the position and velocity of any body, because the measurement of either inevitably produces a change of indeterminate amount in the other. This Principle showed up the fallacy in the old arguments about causality. It is now easy to see, that there is nothing wrong with the old inference that if one knows all about the present one can forecast the future exactly; the trouble is the impossibility of knowing the present. So the doctrine of theorizing only about the observables was not really a useful doctrine. In fact, we may well ask what an observable is, and if we go at all beyond direct sensations—such as physicists intend to do—the answer becomes perfectly indefinite. The idea of causality has thus been relegated from its absoluteness to its proper place; and the New Quantum Theory has convinced us about the failure of the causality principle and has replaced the classical mechanics in the light of observed facts. The idea of logic needs a change in a like manner so that the idea of probability may be brought within the fold of the old logic.

In the early days of Kinetic Theory the central problem was the law of distribution of velocities of the molecules and attempts were made to prove the law absolutely from dynamics. Here we want to know something about the behaviour of a complicated system composed of a great many parts; say, we want to know the pressure of the gas in some vessel. If we tried to attack the question by pure mechanics, we should be faced with an enormous number of mechanical equations for the motions of the molecules, and even if these could be solved the solution would be of no use, because it would depend on the initial positions and velocities of the molecules, and these we should not know. Gibbs considered a very large number of possible states of motion, which have some character in common, such as their total energy, but which were otherwise unrelated. Though each specimen of the motions is quite independent of all the others, he looked at them all together and formed an idea of a canonical *ensemble*. The behaviour of the gas, according to this view, will be determined by the average of the millions of such specimens of the ensemble. With the old mechanics all this involved ideas were hard to accept. The principle of probability, embodied in the averaging over the ensemble, was frankly laid on top of the logical principles of Newtonian mechanics. The real gas in the vessel is not merely one specimen of the ensemble, but is itself the whole of the ensemble. We used to think of the gas as *either* in the state A, *or* in the state B, *or* in C, but according to the new physics we have to think of it as in *all* the states A *and* B *and* C. The principle of probability, which used to be loosely superposed on the old logical principle, is now with the new mechanics fully united with it in a higher synthesis.

We come to the conclusion that the new physics has definitely shown that nature has no sharp edges, and if there is a slight fuzziness inherent in absolutely all the facts of the world, then we must be wrong if we attempt to draw a picture in hard outline. In the old days it looked as if the world had hard outlines, and the old logic was the appropriate machinery for its discussion. Things went wrong when it was found necessary to call in the help of the principle of probability; this appeared first as an alien, but there was hope in the old days that the alien might be naturalized. How far it will be possible to make a full synthesis of the new and the old I do not know, but that some day a real synthesis will be made like that of the NEW Quantum Theory, so that a reformed scaffolding may be constructed on a new principle of reasoning.

In this connection a point may be suggested to the authorities of education. Although the point may be subjected to all sorts of criticisms yet I think that the subject of probability ought to play an enormously greater part in our mathematical-physical education. Things are better now than they were, but mathematicians are still so interested in the study of rigorous proof that all sorts of emphasis go against the study of probability. This should be immediately remedied. This is not to say that special new courses are needed, but rather a change in the spirit of our old courses. When a boy learns about the weighing machine the teacher should emphasise its sensitivity and the length of time that must be taken for the weighing. In giving a problem on projectiles the boy must be taught to consider the zone of danger and not mere-

ly the point of fall. For a rather advanced course, I hope at the school, the teacher should introduce the idea of a distribution law; for example, in doing central orbits Rutherford's law of scattering must be worked out and so on. All these things ought to be examples of a familiar train of thought, and not merely a highly specialised side branch of mathematics at the University.

If these reforms are carried out I shall hope that generations will grow up which have a facility in thinking about the world in the way which the quantum theory has shown to be the true one. Inaccuracy in the world will not be associated with inaccuracy of thought, and the result will be, I am sure, a fuller and better understanding of the basis of natural philosophy.

K. B.

Economic Science and Statistics

Scope and Method of Eonomsi

—R. F. Harrod

THE voice of the new economists—trying to answer to the challenge of the chaotic economic situation on the one hand and of the jeremiads of economists and others on the other,—ring clear and true through Mr Harrod's address, Mr Harrod begins with a short disquisition on the rôle of the methodologist.

Each science or discipline has its own special limitations and conditions; its method of progress has its own special characteristics; within the wide field of logical possibilities some are selected as especially adapted to its problems; it is with this selection that methodology is concerned. And for this reason the methodologist is bound to occupy the rear and not the vanguard. He studies the specific nature of the selected principles after the selection has been made. Methods of course change from time to time; but the actual worker on special problems is more likely than the methodologist to be able to judge the best line of advance. The methodologist's contribution is more indirect.

On first glance this relegation of the methodologist to the rear might seem to give public endorsement to what has all the time been the inward suspicion of the pioneer that he is an utterly useless being. But in fact by reducing his claims he at once becomes much more useful. The forward worker is inevitably influenced by methods used in the past; methods that have already achieved good results may be expected to achieve more; tools ready to hand are taken up. By going over the old ground and making a stricter survey, the methodologist may considerably modify this influence of the past upon the present.

The Economic Criterion

The criterion which the economist has in mind in appraising institutions and practices and making recommendations is that of the "economic good" which determines preferences. It is on the basis of this criterion that economists have been prone to make suggestions. Such advice has been discounted from two quarters, *viz.*, the zealous protagonists for the scientific character of economics, and politicians or moral philosophers. The former group have suggested that

the economist in his advisory capacity should state that a given interference will lead to certain consequences X, Y, Z . . . and then remain silent, leaving his client to decide whether X, Y, Z . . . is a state of affairs which he wishes to bring about. This formulation is in manifest conflict with the actual practice of economists. Also this formulation claims both too much and too little.

It claims too much because it gives an exaggerated idea of the economist's power of prediction at the present juncture. It claims too little because it entails that his advisory power is confined within the narrow limits of his predictory power. Moreover it would make him present his information in a form in which it would be of no use to his client.

The second group of objectors argue that ends are to be determined by them and the economist's function is to prescribe the "economical way" among the infinite alternatives. This criticism, according to Mr Harrod, is not valid, because the economist

uses his criterion both to give advice *simpliciter* and to give it subject to an overriding end furnished to him. If it were true that there is a latent ethical or political bias when he gives advice *simpliciter*, it would be equally true when he advices on the means to achieve an end laid down by moralists or politicians. Without his own criterion, he is entirely stultified. With it, he can give advice of precisely equal validity and freedom from ethical bias whether a specific end is furnished to him or not.

The Analytical Map

The mechanism for testing whether the requirements of the criterion are fulfilled or not is based on the analytical map. The complex phenomena of markets and prices might be regarded as "the result of the efforts of individuals to inform each other of their preferences."

Economists have constructed a map or model in which individuals are seen informing each other of their preferences.

The map is to some extent hypothetical. It supposes that various activities may be interpreted as notifications of preferences. On the other hand it is drawn with reference to the facts of the situation, assuming, if appropriate, such matters as private property, private ownership of land, unequal division of wealth, even special types of banking institution, company organisation, etc., and traces how the mutual notification, which it supposes to be intended, operates in these conditions.

By means of the map we are enabled to get a view of the economic field as a whole. This is necessary for prescription. A particular piece of legislation may be well designed to secure its specific object. All reasonable men will wish to know, and it is the economist's task to say, how this fits in with the larger purpose, for which the whole economic mechanism is designed. To what extent does the specific objective militate against or further the more general purpose?* This can be studied by reference to the analytical conspectus.

How far the facts of real life correspond to those envisaged in the map is a matter of observation and it should be subjected to continuous check. Economists of the past were perhaps too hasty in assuming exact correspondence.

More recently there has been a proper tendency to go beyond this negative attitude and to consider what interferences might be introduced to make the real world more like the map. Recommendations of this sort must be based on a vigilant observation of the actual working of real institutions (but they do not rest on causal laws or predictory powers).

Validity of Economist's Prescription

The rôle of the economist in formulating schemes and giving his judgements becomes, in Mr Harrod's opinion, "more and not less important" in view of recent wide-spread growth of government interference.

Officially sponsored rationalisation schemes, arrangements for the semi-public operation of services, public policy with regard to road and rail transport, marketing board arrangements all require vigilant scrutiny in the light of the criterion, to say nothing of more full-blooded socialist programmes. Even if public policy appears to violate the advice which the economist would give *simpliciter,* this is no excuse for him not to take an interest in the fulfilment of his criterion subject to the overriding demands of policy. He may think that there is no case for giving agriculture special protection; in the face of the opposite policy he has scope enough to criticise the arrangements introduced to give effect to it. If he loses interest in this field of thought, the country is only too likely to get tied up with red tape and be subject to vast avoidable wastage.

A more general objection to the scope of the economist's prescription is disposed of by Mr Harrod in the following lines:

The distribution of income is intimately connected with the balance of social and political forces, the study of which is outside the economist's province. In prescribing here he knows without being told that there are other considerations. This is not to say that he should avoid all questions with political entanglements, for then again he would be almost completely stultified. Most vested interests can whip up some political support. It is a matter of degree and sense of proporion.

It might further be urged that since redistribution is a straightforward matter widely understood, the economist might well leave it alone, since he can but reinforce in technical language an argument already before the public. Projects of redistribution, however, may have complicated ramifications which the economist is especially qualified by his other training to trace out. For instance, in his *Public Finance* Prof. Pigou has worked out with great elaboration the principles and consequences of a redistributive system of taxation. It may safely be said that this work would have been beyond the powers of any but a highly trained economist.

Dynamic Economics

The most significant portion of the address, however, deals with the study of 'dynamic' economics, as a department wherein future progress is likely to lie. The 'pure theory of traditional economics' has been concerned mainly with the 'static theory' of value and distribution, which were elevated by Ricardo to the status of being regarded as "the principal problem of Political Economy." Mr Harrod is critical of the potentialities of this line of investigation.

* If I interpret him aright, this account is in accordance with the view expressed by Prof. Robbins in his section on 'rationality' in the concluding section of the *Nature and Significance of Economic Science.* Cf. also Prof. G. Cassel, *Fundamental Thoughts on Eonomies,* p. 14.

The theory of value and distribution seeks to show how a number of circumstances taken as given (the fundamental data)—namely, the preferences and capacities of individuals and the available resources—serve to determine a structure of output and prices. If a change in these data occurs, the theory professes ability to predict the consequences within certain limits on the price-output structure. This professed ability to predict implies that we have available certain general laws concerning the succession of events, causal laws in fact.

The causal laws of static theory are deducible from the law of demand. This is well based on a very wide experience. it is in no need of verification; further attempts to verify it could not add to the assurance with which we already hold it. But the laws are of a very general form and little prediction can be based upon them, nor are they the source of the recommendations of traditional economics. More specific laws would have to be based on detailed empirical research and would be highly conjectural. While great interest attaches to such empirical work, it is not clear that this should be the main avenue for future developments; but, if it is not to be, then the general theory of value must itself be displaced from its central position.

His plea for a departure in methodology in relation to the study of 'dynamic' economics will be explained by the following extracts:

I believe that there ought to be alongside of static theory a body of laws relating to the increase (or decline) of economic magnitudes, and that with the aid of a very few empirical generalisations, having high authority if somewhat less than the law of demand itself, it may be possible without more ado to construct such a body of laws. I conceive the analogy between the relation of dynamics to statics in mechanics and that of this branch of economics to the static theory to be much closer than that implied in recent uses of the word dynamics in economics. While the equilibrium price determined by the maintenance of a steady flow of demand and supply corresponds to a state of rest, new equations would be formulated to determine regular movements in the economic magnitudes under the influence of growth of population, savings, inventions, etc.

This line of thought is not, of course, new. The classical economists attached great importance to the alleged tendencies of rent to rise and profits to fall. Such considerations are not absent from Marshall. But generalisations of this kind have tended to recede from view both to their conjectural character and to the more precise formulation of static propositions in a mathematical garb. The existence of this formulation has in turn tended to lead monetary and trade cycle theorists, who are interested in change as such, to regard the phenomena of their study in terms of transitions from one static equilibrium to another. It may be that they would be greatly assisted if they could regard them as departures from or oscillations about a path of growth; but they can only do this effectively if the laws governing increase are as precisely formulated as the static laws. We need a system of fundamental equations using simplifying assumptions; *cf.* the frictionless surface, etc., in which rates of increase will themselves figure as unknown terms.

Empirical Studies

The concluding section deals with what the speaker realises to be 'the most difficult, the most tentative, and withal the most important' studies; which he expects to be 'the most important in the future.' The high importance of the work of classification, constituting the 'major part of traditional economic theory,' should be recognised; and the empiricist, however radical, is warned, that unless he can use this as an indispensable tool for further investigation, he is likely to founder. Undoubtedly, a large part of economic classification is based on experience but what is wanted is closer investigation. Taking an instance from the study of trade cycles over which Mr Harrod very justly, though humourously claim "certain proprietary rights," he states:—

It is an accepted generalisation, not indeed possessing the universal validity of the law of demand but none the less of substantial authority and interest, that in the upswing of production prices have a rising tendency and in the down swing a falling tendency. It may safely be said this could not be deduced from the propositions of static theory nor from that part of momentary theory which is deducible from them. Falling prices would be regarded as an equally (if not more!) likely accompaniment of rising output and *vice versa*. The generalisation is a direct result of observation, an excellent example of the facts speaking for themselves. And if theoretical explanations have subsequently been woven round it, this must not blind us to the true source of our knowledge. If rather crude observational data can yield appetising morsels of this sort, may we not legitimately hope that when subjected to refined statistical treatment they will yield more fruit in plenty? It will still be necessary to relate such generalisations to each other and to those of a more deductive origin in an orderly fashion.

Mr Harrod puts in a strong plea for the 'endowment of full-time workers of the right temperament and the provision of adequate laboratory

equipment and skilled assistants and ends in an optimistic note.

> I believe that we may be on the eve of a great advance in economic theory, taking us right outside the ambit of the static system of equations. The wealth of statistical data, together with the indications resident in the trade cycle that the succession of events is governed by laws still undiscovered, should be a spur to the inventiveness and enthusiasm of every student to whom the ways of science make appeal. He may reasonably feel that any day he may light upon some general relation of wide validity, satisfying to the intellect and capable of yielding vast benefit to humanity. The prospect is an inspiring one.

An Indian reader might pertinently observe in Mr Harrod's address a justification of the empirical investigation and analysis carried on under the name 'Indian Economics.' The study of economics must needs be supplemented—and that in an adequate manner—by close observation of the facts and factors around us. For such a task if British academic workers are handicapped because of the heavy burden of 'teaching and administrative duties,' how much more true it is of workers in India. The state and community can only neglect to note the need for economic research and field-work, at their own peril.

B. N. B.

Chemistry

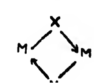
Recent Investigations in the Chemistry of Gold

—Prof. Charles S. Gibson

PROFESSOR Gibson in his address has made a review of the recent work on the preparation, properties and the structure of gold compounds, specially of those containing organic radicals or co-ordinated organic molecules. A notable contribution to the subject has been made by Prof. Gibson himself and his co-workers.

By the results of these investigations it is now realized that there are fewer anomalies among the metals of the sub-group I B, copper, silver and gold, than was formerly believed. These, however, differ widely from the alkali metals except in the fact that they are all capable of being univalent. This difference between the metals of the two sub-groups is to be attributed to their different electronic structure. The metals of the sub-group I B have eighteen electrons in their penultimate electronic group whereas the alkali metals have only eight electrons in that group. The multivalency of copper, silver and gold results also from this eighteen electronic group. The univalency and bivalency of copper and silver are well-established, but gold can exist only in the univalent and tervalent conditions. This distinguishes it from copper and silver.

Argentous silver differs greatly from cuprous copper and aurous gold. There is no evidence for the existence of any normal aurous salt and some cuprous salts are very unstable. Cuprous and silver halides, on the other hand, in the solid state are non-ionic and isomorphous. As cuprous chloride is bimolecular, the cuprous atom in its halides is possibly bi-covalent. From recent chemical evidences, this is also true of aurous gold in aurous halides. Hence it is concluded that cuprous copper, argentous silver and aurous gold in their halides are 2-covalent and have the general formula

where X=halogen. 

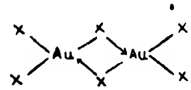
Unlike bivalent copper, bivalent silver is unstable and exists only as a complexion, *e.g.*, *bis-αα'* dipyridyl argentic persulphate, *tris-αα'* dipyridyl argentic nitrate, perchlorate etc. Hence bivalent silver may have co-ordination members of 4 and 6. On the other hand, bivalent silver resembles bivalent copper in forming an inner mettallic complex with picolinic acid having a planar structure as shown by Cox, Wardlaw and Webster (1936).

That cuprous copper and argentous silver can exhibit 2-and 4-covalency is well established. This is evident from the composition of various cupro- and argento cyanides. But the only complex cyanide

of aurous gold—potassium auro-cyanide—has only a co-valency of 2 for the aurous atom. This is also evident from the crystallographic investigation of tri-alkyl phosphine and tri-alkyl arsine derivatives of cuprous, silver and aurous halides. Study of the compounds of thioacetamide with cuprous, argentous and aurous halides leads also to the conclusion that aurous atom cannot exhibit a co-valency higher than two.

The tervalent gold alone is always co-ordinated and is 4-covalent, with a planar configuration. Hence optical activity can only be sought in 4 covalent aurous compounds, if they can be prepared, with tetrahedral configuration.

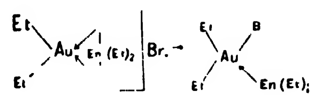
Like the aurous halides, aurichalides are also complex and should not be represented in the normal way, auric gold is always 4-covalent. This is true also of more recently investigated compounds like hydronitroauric acid, hydrosuccinimido chloroauric acid, hydrophthalimido hydroxyauric acid and hydro methyl glyoxivinylboromo auric acid. It was already shown by Fisher (1929) that molecular formula of auric chloride is Au_2Cl_6. The composition of this and the analogous bromo-compound should be represented by general formula



(X=Cl or Br). They should, therefore be termed tri-chloro, and tri-bromo gold.

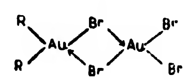
Chief advances in the chemistry of gold have been achieved by Prof. Gibson and his colleagues from a study of the organic derivatives of gold and specially of certain types of organic sulphur compounds.

As a product of the interaction of the Grignard reagent and the pyridinotrichlorogold, di alkyl halogeno gold compounds were prepared. These were found to be non-electrolytes, with molecular weights twice that represented by their empirical formula. They and their co-ordination compounds all contained 4-covalent auric gold. This led to the conclusion that the 4-covalency is an essential feature of all auric compounds. Among these compounds mention may be made of diethylmonobromo gold, aminoethylbromo gold, pyridinodiethylbromo gold, dibenzyl sulphidediethylbromo gold and acetylacetonediethyl gold. The change of mono-ethylenediaminotetra-n-propyldibromodi gold by heat indicated that suitable organic gold compounds may be the potential source of free radicals and that it is possible to prepare mixed auric-aurous compounds containg 4-covalent auric gold and 2-covalent aurous gold in the same molecule. Other cases of compounds containing two 4-covalent auric gold atoms in the molecule, which similarly break down with the initial production of free radicals and simultaneous formation of a mixed auric aurous compounds have also been reported. Such decompositions suggest the possibility of establishing the existence of aurc-auric halides of the formula Au_2X_4 (formerly written as AuX_2 and given as examples of bivalent gold) as intermediate products in the decomposition of the trihalides to the mono halides. The interaction of diethylmonobromo gold with the asymmetrical N diethylethylenediamine (Brain and Gibson, 1938) results in the production of a colourless crystalline compound soluble both in water and benzene. It appears therefore to be both a salt and a non-electrolyte. This constitutes a unique case of tautomerism, of course, not resonance. It dissociates in aqueous solution but shows considerable association in organic solvents. Its constitution should be represented as:



where Et—ethyl group: $En(Et)_2$—N-diethylethylenediamine.

Monoalkyl (ethyl and n-propyl) dibromo gold compounds also have been prepared by the action of bromine upon dialkylmonobromo gold compounds. Their molecular weights show that they are dimeric $(RAuBr_2)_2$ and their high dipole moments suggest an unsymmetrical constitution:



This is in keeping with their formation from equimolecular quantities of dialkylmonobromo gold compounds and tribromo gold and with their physical and chemical properties. Their decomposition into alkyl bromide and aurous bromide (Au_2Br_2) furnishes a chemical evidence concerning the constitution of the latter. Chemically these compounds behave as equimolecular mixtures of gold tribromide

and the dialkyl monobromo gold. The preparation of a 4-covalent complex auric salt with a tervalent cation diethylenediamine gold tribromide [Au En_2] Br_3 and a univalent cation—ethylenediamine dialkylgold bromide [R_2AuEn] Br have also been reported (Gibson, Simonsen and Colles, 1930, 1931). The former belongs to the class of complex auric ammines described by Weitz (1915).

By the direct action of silver cyanide on the dialkylmonobromo gold compounds Prof. Gibson and his colleagues have succeeded in preparing the corresponding cyanoderivatives. These compounds have unique properties and their detailed investigations have revealed a number of interesting features in connexion with the general chemistry of gold.

Unlike their anologues, the dialkylmonocyano gold are tetrameric and contain therefore four atoms of tervalent gold in the molecules. In the molecule of such compounds gold atoms must be attached to the carbon atoms of the cyanogen groups and the nitrogen atoms must be co-ordinated to neighbouring gold atoms.

This gives rise to a symmetrical twelve atom planar ring structure. This is in keeping with the stereochemical configuration of the cyanogen group, with the low dipole moment for the n-propy compound, with the 4 cavalency of the auric gold atoms and with the result of X ray crystallographic investigation. The decomposition of these compounds have been quantitatively investigated. As intermediate products of decomposition mixed 4 covalent auric and 2-covalent aurous compounds have been obtained as in the halide series. The final product is monocyano gold (aurous cyanide). This decomposition affords chemical evidence regarding the constitution of the aurous cyanide, indicating that it is a non-electrolyte 2-covalent tetrameric aurous compound and that like its parent compound it is planar. As in the case of the halide series the decomposition of the parent compounds proceeds with the evolution of gas indicating the initial production of free radicals. These latter were not identified as such but as the paraffin hydrocarbons to which they should give rise.

As a result of X-ray crystallographic investigations by Powell and his collaborators on organic gold compounds, on Mann's co-ordination compounds of aurous gold by Wells and potassium bromoaurate by Cox and Webster, the planar configuration of the four valencies of tervalent gold and the linear configuration of the two valencies of aurous gold have been well established.

The result of the X-ray study of the simplest organic gold compound, diethylmonobromo gold has been discussed and the projection of the molecule on the plane of the gold and bromine atoms is represented by diagrams. An interpretation of the X-ray study of the much more complicated compund, di-n-propylmonocyano gold, illustrated by figures, is given, which strikingly confirms the constitution deduced from the chemical and physical properties of the substance. In the case of the previous compound also the structure suggested by the X ray data is in agreement with that deduced from molecular weight determination and electronic structure.

A detailed consideration of the properties of the bis (dibenzylsulphidodibromo gold), which is prepared by mixing equimolecular quantities of 2-covalent aurous compound, dibenzylsulphidomono bromo gold and 4-covalent auric compound, dibenzyl sulphidotribromo gold in a suitable solvent, present certain interesting features. The apparent molecular weight of the substance in freezing bromoform affords no information as to its constitution. The knowledge of the chemical and physical properties in this particular case is inadequate for determining the constitution of the substance in the solid state. The constitution suggested on the basis of the recognized principles of co-ordination can only be tested by a careful crystallographic and X-ray analysis. Two possibilities in the linking up of aurous and auric compounds in this case have been suggested by Prof. Gibson: (a) the aurous gold atom may become 4 covalent with a tetrahedral configuration assuming an Effective Atomic Number of 86, or (b) the auric gold atom may become 5-covalent with a pryamidal configuration and assuming an Effective Atomic Number of 86. For a decision on this point and similar vexed problems chemists, as Prof. Gibson points out, will have to rely almost completely on crystallographic technique for the determination of the constitution of substances.

P. R.

Geology

Development and Evolution

—Prof. H. H. Swinnerton

BIOLOGISTS and palaeontologists both agree that a specific individual, in developing from an embryo to an adult, through epembryonic or neanic stages, recapitulates at a certain stage of its life-history, the general or some specific character observed throughout the evolution of its race, or more technically and concisely, 'Ontogeny repeats Phylogeny.'

Now the point in dispute between these two classes of workers, is whether or no the adult conditions of the race are recapitulated in the young stages of the individual. Some thinkers, especially upon the biological side, say emphatically 'No.' Others, especially, invertebrate palaeontologists, say 'Yes.' The divergent views have arisen chiefly because of the different types of material the two classes of workers handle. But in so far as they are on the whole dealing with different portions of the same life history, the biologists being concerned with embryonic, larval and foetal stages and the palaeontologist with the neanic stage which is more abundantly preserved in the fossil state, their observations and conclusions are not contradictory but suplementary. It seems appropriate therefore that an attempt should be made to re-examine the evidence in the hope of gaining a clearer understanding of the relationships of the various view-points to one another. From such a survey geology and biology have much to gain.

The two viewpoints may be summed up here: (1) 'The young stages in the development of an animal are not like the adult stages of other animals lower down in the scale but are like the young stages of those animals' (Von Baer), and (2) Haeckel's teaching, *viz.*, 'The adult stages of the ancestors are repeated during the development of the descendants, but are crowded back into the earlier stages of ontogeny, therefore making the latter an abbreviated repetition of Phylogeny' (v. de Beer). This is variously referred to as the Theory of Recapitulation, the Principle of Palingenensis and the Biogenetic Law.

Any consideration of the relationship of development to evolution must deal with the subject from two aspects, *viz.*, *retrospective* and *prospective*, that is whether the evolutionary changes of the past are reflected in development and if so, to what extent (retrospetive) and whether future evolutionary changes of sudden or of sequential character are foreshadowed in development (introspective).

Restrospective Aspect

An examination of the forms typical of various phases in the evolution of the coral gens *Zaphrentis delanouei*, through the *Z. delanouei* (*s. str.*) *Z. parallela*, *Z. constricta*, and *Z. disjuncta* (early, typical and advanced) stages, showed clearly that specific recapitulation of adult characters had taken place. Thus the penultimate stage in the growth of *Z. parallela* bears a much closer resemblance to the adult of the ancestral species *Z. delanouei* (*s. str.*) than it does to the adult of *Z. parallela*. Similarly, the penultimate stage in the development of *Z. constricta* repeats the sum total of the characteristics distinctive of the adult ancestor *Z. parallela*, whilst the antepenultimate stage exhibits a similarly close resemblance to the ancestral adult *Z. delanouei* (*s. str.*).

A more recent examination of the same material revealed several earlier stages than those just mentioned these however closely resemble the correspondingly young stage of the ancestor *Z. delanouei* (*s. str.*). They provide therefore an excellent example of the recapitulation of juvenile conditions described by Von Baer and emphasised by modern biologists, as the later growth stages provided for the recapitulation of adult conditions reiterated above. Further, one also recognises that the embryo in this case appears to retain features characteristic not only of the embryonic stages of other species of *Zaphrentis*, but also of other members of the phylum. This fact also shows that the principle is applicable to forms belonging to different periods of time as well, and that its application is not restricted to contemporary animals alone.

The embryonic condition must be regarded as the culmination of a long process of evolution of embryos in which many factors which concerned the adult life have played no part, but in which factors foundational to adult development have been preserved. The neanic stages, on the other hand, have recapitulated the adult condition exhibited by the preceding members of the gens to which the species belongs. Further, within the neanic stages, the principle of acceleration or tachygenesis is perfectly exemplified, but its action so far as the adult combination of the features is concerned, does not penetrate back into the transitional and embryonic stages.

The same phenomena as described above are also met with in foraminifera, (*e.g.*, in the *Operculina--Heterostegina--Cycloclypeus* series), in lamellibranchs (*e.g.*, the gens *Gryphóéa incurva*), and in other groups of animals as well. From a general survey of all groups of animals, one overruling fact seems to emerge, *viz.*, that the more lowly and simple the organism the more complete is the recapitulation.

Localised Recapitulation and Recapitulation in Colonial Organisms

Phenomena of localised recapitulation which have a bearing upon the problem under discussion are commonly observed in those parts of the body which are metamerically repeated or are reproduced by budding, *e.g.*, the ambulacral plates of echinoids. In *Hemicidaris*, the newly formed plates in the upper part of the body are like those fully grown plants of the earlier genera Lepidocentridae in form and number of pores, which is an instance of adult recapitulation. Similar phenomena are also observed in the metamerically repeated parts of organisms living in colonies, *e.g.*, the polyzoon genus *Stromatopora*.

However complete and specific the recapitulatory record may be at the outset, in subsequent generations it becomes curtailed as the result of increasing acceleration in individual development. This leads to the skipping of stages either by a 'mere shortening of ontogeny' in cases where evolutionary trends remain constant, or by a 'straightening of ontogeny' where new trends, out of accord with the foregoing, set in. The record also becomes vitiated as the result of the fact that acceleration is not constant for all features, and consequently the combination of characters exhibited by the adult ancestor becomes broken up, or even eliminated from the development of the descendants.

Prospective Aspect

Though Haeckel's main emphasis was upon recapitulation, he realised that factors which were at work, tended to vitiate the developmental record. Among these was the appearance, in larvae and embryos, of features which were adaptations to the conditions under which these immature organism lived (Còènogenesis). Although some còènogenetic characters apparently exert no appreciable direct influence upon the later stages, there are others which may possibly have exerted a radical influence upon subsequent growth and evolution, *e.g.*, the rotation through nearly 180° of the visceral hump with its shell in some gastropods whilst they are still in an embryonic stage. This còènogenetically introduced character does not displace but plays its part along with those which belong to the ancient category.

There are other còènogenetic characters however which extend gradually, during the process of evolution, into later stages, (Proterogenesis) as in the case of the *Rhynchorthoceras-Lituites-Cyclolituites series*. In the first, the shell is wholly straight or slightly curved, in the second various degrees of coiling are shown, and in the last the shell is almost completely coiled.

As opposed to còènogenesis, there is the case of the appearance of new characters at the latest of the gens *Gryphóéa incurva* in stages (Deuterogenesis), *e.g.*, the coiling in late forms of the gens *Gryphóéa incurva* were anticipated in late stages of growth in the earlier forms.

Whilst in some groups new types appear in sequence at relatively wide intervals of time, in others, they come on quite rapidly, and in yet others they appear almost, if not quite, simultaneously. In the last case, the process at work, may be neither tachygenesis nor proterogenesis, but simultaneous mutation in the biological sense. The close resemblance to progressive evolution with the passage of time may thus be due not to evolution but to elimination. This is illustrated, among

others, by the suberaspedites fauna (ammonites) of the basement beds of Spilsbury sandstone. Here, side by side in the same layer, which is only several inches thick, occur a series of forms ranging from *S. primitivus* in which the whole shell possesses a fine ornamentation, to *S. cristatus*, in which very coarse ribbing is dominant.

The condition of preservation of the specimens in the actual deposits proves that the individuals whose remains have been found were practically contemporaneous with one another. Although the case for such an explosion of serial mutants cannot be regarded as established, yet there is sufficient evidence to warrant us in taking this suggestion seriously. Should its occurrence be established, it would provide a marked contrast to the type of mutation made familiar by the experimental work of biologists. The contrast should probably be regarded as due to differences in methods of study and of material. The experimenter breeds with isolated and controlled pairs, whilst nature breeds in a large freely mixing population with pairs drawn together by instincts that are yet beyond the experimenter's ken. Made matches do not necessarily yield the same results as love matches.

The Inter-relationship of Processes

While, for the sake clearness, the several processes concerned in the survival during development of old characters and in the arrival of new ones have been considered separately, this is not the mode of their occurrence in nature. On to the background of characters representing the survivals from the past, *viz.*, the features forming the basis of the theory of recapitulation, characters which express in gradually varying degrees the similarity between the forms in the succession of stages passed through in development and attained in evolution, are superposed all new characters. These, generally speaking, belong to one or other of two categories. *viz.*, (*a*) *Unit or biocharacters*—features which appear fully expressed from the outset and undergo no subsequent change, *e.g.*, torsion in gastropods, and (*b*) ***Trend characters*** or *bioseries*—features which at the time of appearance are almost imperceptible but which in subsequent developments become progressively more fully expressed, *e.g.*, length of septa in corals, coiling in *Gryphœa*.

Unit characters may appear cœnogenetically, that is to say, at some early stage in development, and may or may not open the way to other changes of a serial quality. Trend characters on the other hand, arise either cœnogenetically or deuterogenetically and proceed proterogenetically or tachygenetically towards later or earlier stages in life-history respectively in successive generations. In both cases the advancement of the trend is accompanied by a displacement of homologous characters—that is to say, characters situated in or on homologous parts. In the former case displacement is towards late life and culminates in the disappearance of older characters at the end of life. In the latter, displacement is towards early life and ends, usually at the junction of the embryonic and neanic phases, in the elimination of these characters (lipopalingensis).

Although there seems to be reason why both types of development should not proceed simultaneously in a series of solitary organisms for different sets of characters, but hitherto no examples of this has been detected. That they may occur in sequence or simultaneously in closely allied organisms is well-illustrated by the history of certain colonial forms, more especially graptolites.

P. K. G.

The Changing Outlook of Engineering Science

—Prof. R. V. Southwell

PROFESSOR Southwell stated that previous presidential address mainly dealt with particular problems, *e.g.*, the organization of applied research, training of recruits for industry, certain topics of practical engineering etc. It is, however, desirable under the present conditions to have a general stock-taking to view the trend of engineering science from both practical and academical standpoints, both as an art and as a field of study, teaching and research. And meanwhile all the circumstances which should influence our policy—the trend of modern physics, the attitude of industry towards the university graduate and the nation's organisation for applied research, have altered profoundly. Such trend of engineering concerns the teaching profession as well as those engaged in practical engineering. He presents his views under three main headings: (*i*) our policy in regard to the teaching of the engineering science; (*ii*) our policy in regard to engineering research; and (*iii*) foreign policy of our relations with the community.

Engineering, he says, was defined by Thomas Tredgold as 'the art of directing the great Sources of Power in Nature for the use and convenience of man': engineering science, therefore, is defined as science studied with a view to application. It can be supposed to trace its ancestry back to Archimedes or even further; for its name shows geometry to have originated in surveying. But notwithstanding this very respectable pedigree, until 1840 it was not admitted as a subject for university studies. Hence from the university standpoint its history is short: nor from the experience gained in allied subjects of university teaching it is possible safely to argue regarding its present policy. Unlike other university studies, the problems relate very largely to those of practical value, not simply as a means of training the young generation to lead to proper thinking. The content of the subject is determined not only by the growth of knowledge but by the actual trend of practice. What should be the content of university training? What is to be the policy in the face of this continuous accretion of knowledge, seeing that there is no corresponding increase in the capacity of the under-graduates to absorb?

The policy must be dictated by circumstances, and our circumstances have changed most drastically since the war: first by the trend of modern physics which has profoundly altered the relation of pure and applied sciences; secondly by an unprecedented growth of industrial and government institutions concerned with scientific experiments. As to research it has always been held that in universities it must find justification not in what is consequence: the utility of its result but in what is intrinsic: the urge of the scientist to discover like the urge of an artist to create is something that will not be denied. Engineering is not, like Chemistry and Physics, a separate branch of natural philosophy but natural philosophy studied from a particular standpoint and with a special purpose. One can, therefore, argue that as a logical outcome the study of engineering is that of a non-specialist. The industry would demand more and more for specialists and therefore they would seek for people trained in laboratories appropriate to pure sciences.

The aforesaid reasons indicate that at the present moment a dilemma confronts all teachers of engineering science. On the one hand more and more specialised knowledge finds applications in engineering practice and on the other hand our industrialists are well disposed to the engineering graduate and they seem agreed in demanding that students shall come to them as men who have been educated to take wide views, trained to think and qualified to negotiate and control. It is not possible to reconcile specialisation in training as well as to secure a wide outlook. The power of the average under-graduates to absorb and assimilate has not been found to have attained noticeable increase nor the period of study could be extended. There is thus the problem for the university teacher to decide not what subjects of instruction should be included because of value but what can be omitted on the ground that, pushed into a mind already taxed it will push out something still more valuable.

So every lecturer will want, as he approaches the allotted boundary of his subject, to move that boundary just a little back, into fields he sees that are rich and fruitful. There is, however, a danger in this procedure since neither in a lengthening nor in an intensification of courses shall we find more than a temporary and makeshift solution of our problem, since it would fail to satisfy the demand of industrialists for men of personality educated to take wide views.

First of all, we must decide the purpose which our courses are meant to serve. The view point is clear cut: their purpose is to train recruits for industry and the taking of a good degree in the final examination should indicate an assimilation of engineering principles adequate in a man who is starting a professional or industrial concern - but *not more than this.* One can object that this makes no provision for the really first class man. Is it possible in a written examination to detect first class ability? If by first class ability it is meant ability to do research, the answer would be-- examinations are not its best detector since their proper function is to test that what has been taught has been absorbed. It can only be revealed by research actually performed. About examinations, Prof. Southwell urges "*On all counts let us shun harder papers in our examination*". At the worst the subject matter of the harder papers are based on some special course of lecture delivered with a view to some special paper.

What is wanted, therefore, is to work out a plan whereby the industrialists may be provided with men who with adequate knowledge of engineering principles combined with some breadth of background and who by intercourse with men of other training have gained maturity of bearing. We must not forget the importance of leisure to the formation of personality. Stated broadly it is emphasised that lecturers should not exclude matters not found in a syllabus.

Regarding problems of research every teacher will feel that life would be a duller thing if teaching were all, if we ceased to have zest for the unsolved problem and the rarer thrill of the problem solved that every researcher knows though the poblem is of interest to himself alone.

There is, however, the pessimistic forecast that engineering research at universities is doomed to ultimate extinction because as engineering comes to make ever fuller use of mathematics, physics and chemistry, more and more its problems will be such as only specialist in those subjects can investigate while for *ad hoc* experimentation generous provision exists and will increase in government institutions and in the research departments of our larger works. This view of pessimism seems at first sight most strong. It is however most easily answered, from the consideration *viz.*, that the attitude of the engineer to his problems is something both peculiar and worth preserving.

As an explanation, a comparison with the outlook of mathematicians and physicists will be interesting. The physicist thinks that his problems are inexorable. If he finds difficulties of progress along an attempted path he is free to try some other: the engineer has to solve the problem as it is presented and some solution he must have, even though it be only approximate. It has been the fashion of late to jeer at the engineer's "factor of safety"—changing its name to "factor of ignorance" and ascertaining that like charity it covers a multitude of sins. This criticism, one admits, to be largely true as regards the past: but the time is near when the 'factors of safety' would be decided by values strictly dependent on the reliability of our materials. The pure physicist can choose his materials according to his own need whereas the engineer is not free to choose. His materials are dictated by various factors *e.g.*, constructional or manufacturing requirements, the consideration of strength of cost, etc. Practical engineering has evolved to its present state and there are problems far too difficult for routine investigations--there will still be the scope for academic engineers, they possess a sense which is worth considering. They can visualise and the engineering student who intends research, this gift of visualisation would be a great asset and must be fostered deliberately.

Time is coming when the engineer shall have methods of his own for doing most of what hitherto they have looked up to professional mathematicians to do for them. These methods may not be (exact in the mathematical sense but they will be) none the worse for that, even philosophically speaking. In practice data are subject to a margin of error, no less than the quantities required and such methods, therefore, are of extreme help in working out real problems.

The school of engineering will find problems different from those which engaged their engines a generation ago. Prof. Southwell is of opinion that university research is approximating more and more closely with the passage of time to what in the last century was called Pure Physics. Avoiding mention of the living, it is in Osborne Reynolds and Ewing -yes, and Clark Maxwell, Rayleigh, Kelvin, Heaviside in some of their manifold activities—that future professors of engineering will find them ideals which they should aspire to emulate. Their aim will be, not so much to make inventions in the manner of Bessemer Parsons, Otto, Diesel or to test the working of large prime movers or to break new ground in physics that has application to engineering—more specially near the border lines that tend always to be drawn too sharply when research is highly organised. In future, the universities must maintain that irresponsible quality which otherwise research is in danger of losing precisely because now it is taken so seriously, as a matter of national concern.

Coming to the third heading, *viz.*, "The Public Relations" or engineering as its concerns the community, there seems to be an implication in much that is written nowadays that because range of engineering includes guns, battle-ships, aeroplanes and tanks, engineers are to be regarded as a class, more than other, responsible for the horrors of modern war. Prof. Southwell records his protest against these implications and quotes from the presidential address to the Association by Sir Alfred Ewing.

"The cornucopia of the engineer has been shaken over all, scattering everywhere an endowment of previously unpossessed and unimagined capacity and powers. Beyond question many of these gifts are benefits to man making life fuller, wider, healthier, richer in comforts and interests and in such happiness as material things can promote. But we are acutely aware that the engineer's gift may be grievously abused. In some there is potential tragedy as well as present burden. Man was ethically unprepared for so great a bounty. The command of nature has been put into hands before he knows how to command himself".

There is no subject in which clear thinking is wanted to-day. The desire to hand on responsibility is so deep-seated, that the will to believe that we could have had the benefits of sciences without its risks and temptations has gained ground. But knowledge is of good and evil; it is of its essence that we can not know how to cure poison without knowing poison and its action, how to control and use explosives without acquiring power for harm as well as for good. Knowledge is not moral. Good and evil are its opposite sides inseparable in its very nature. One can not have sympathy with the plea for a cessation of scientific activity: it is arguable that on balance knowledge is undersirable. When men talk of beneficient or destructive science as though one could be free to pick and choose, it is proper to say that they have not even begun to understand what science is.

Increasingly it appears that nations are inclined to put trust in adroitness rather than in the sincerity of their statesmen. Ethics are out of fashion and while as individuals we may still admit the moral imperative, the notion that motives recognisable as moral can have place in international affairs seems now to be rejected as impracticable idealism.

Prof. Southwell believes that some scientific leaven is beneficial in almost any body of administrative humanists. Rather than seeking to defend the activities of engineers from the charge that evil can come of knowledge misapplied, might it not be better to undertake a harder task, trying to instil into the mind of the public a clearer notion of the aims with which the real scientific work is done. Never have greater powers of exposition been devoted to the popularisation of science. It is not of the treasure found, but of the *quest*, to show the true man of science, neither as a care-free dilettante nor as a philanthropist but seeking truth like the artists; a spirit that breathes in every book of science worth the name. Let the scientist have the courage of the artists to exalt our calling while deploring the folly that has led us and other men to misuse them. Let us not weakly question that the gifts of science hold potential good. The record of engineering is not such that one needs feel ashamed of the calling.

P. N. G.

Anthropology

The Orient and Europe

—Prof. V. Gordon Childe

PROFESSOR Gordon Childe upheld the claims of Prehistory as an experimental science. He pointed out that Prehistory is based upon solid facts like "relics and monuments" which are always available for all to be examined and verified.

Prof. Childe critically examined the axioms propounded by Montelius in 1899 in his "*The Orient and Europe*." The fundamental assumption of Montelius was *Diffusion*. Montelius compared the written records of the Orient with those of illiterate Europe and came to the following conclusions:

(1) Civilization in the Orient is extremely ancient;

(2) Civilization can be diffused;

(3) Elements of civilization were in fact diffused from the Orient to Europe;

(4) The diffusion of historically dated Oriental types provides a basis for bringing prehistoric Europe within the frame work of historic chronology;

(5) Prehistoric European cultures are poorer than contemporary Oriental cultures.

The antiquity of oriental cultures is firmly established. Excavations in Egypt, Mesopotamia, Syria, Anatolia have proved it beyond doubt. Recent excavations by Prof. Frankfort at Tel Agrab, Tel Asmer and Khafaje have emphasised the antiquity of the oriental civilization and the long duration of the Early Dynastic Age. Further excavations at Erech by the German school have led to the discovery of the wall stumps of a gigantic edifice below the earliest dynastic temple ruins (Jemdet Nasr period) rested upon the ruins of a no less imposing building, which has been called the Red Temple. The Red Temple was constructed on another imposing cathedral known as Limestone Temple, because of its unusual stone foundations. Below the floor of the Limestone Temple 18 layers, marked by various associations of human occupations were discovered. Prof. Childe puts the date of the above culture roughly at 4500 B.C.

Geologically the delta of Lower Mesopotamia is very recent and none knew that it was the cradle of food production. The al' Ubaid culture was already mature and the spades of Mallowan and Speiser in Syria and Assyria have yielded the earlier stages of al'Ubaid. Relations with Lower Mesopotamia were so close and continuous that the discoveries from the prehistoric levels of Gawra, Nineveh and Chagar Bazar were found to be parallel to those from the protohistoric levels of Sumer. Prof. Childe puts the date of these prehistoric finds to the 6th millenium B.C. approximately. These prehistoric finds in the Near East resemble European neolithic in having the continued use of the polished stone adzes and some other tools; but the earliest cultures of the Fertile Crescent like its Early Dynastic cities are so unlike anything known in Europe "as to seem incommensurable". The Oriental Institute of Chicago has also discovered the evidences of intercourse between Anatolia and Mesopotamia. The Anatolian chalcolithic, according to Prof. Childe seems to be rooted in 4th millenium B.C. but the earliest remains are quite uncertain. All these above would appear to support axiom (1) of Montelius but the connections between Asia and Europe have recently been proved by Heurtley's excavations in Macedonia. Heurtley has convincingly demonstrated the Anatolian ancestry of the Early Macedonian Bronze Age. The Macedonian relics can be well compared with the Danube basin and there was a cultural continuum traversing the Balkans connecting the Aegean coasts with the Danube basin." These justify the validity of the axiom (3) of Mentelius *i.e.*, diffusion from Asia to Central Europe.

Turning to the prehistoric chronology of Central Europe, Prof. Childe remarked that the tentative suggestion of the culture sequences made by him some ten years ago have now been fully corroborated by Buttler's investigations in Germany and Banner's researches in Hungary. These phases have no counterpart in the Orient. The earliest

bronze objects found in Central Europe are associated with Aunjetitz culture and all the type-fossils can be traced back to about 3000 B.C. in the Orient. Thus the beginnings of the Continental Bronze Age according to Montelius' axiom should be nearer to 2800 B.C. than 1800 B.C. Oriental parallels can be found to the types found in the earlier period of Central Europe of which Danubian I belongs to the earliest neolithic culture. The latter can still be limited by Tel Halaf and Prof. Childe would assign the date of 6th millenium to both the above cultures, and according to him the Danubian VI belongs to 1200 B.C., the Danubian V to 1700 B.C. and the Danubian IV to 3000 B.C. Under the 4th axiom of Montelius only upper limits of the oriental analogies are provided and Montelius' 5th axiom appears now tó be fully justified on the findings of early settled cultivated life beneath the Tel Halaf villages and they thus seem to be more advanced than that of the ancient Danubians. The Vardar-Morava culture even can hardly be put in relation to Oriental cultures. Objective proofs of cultural continuity between the Near East and Central Europe by diffusion are still lacking and the beliefs regarding the foundations of agriculture, stock-breeding etc. are mere hypothesis. The Balkan regions are yet unexplored and we must wait till confirmatory evidences are forthcoming from there.

Psychology

Eye and Brain as factors in Visual Perception

— R. H. Thouless

We not only see with eyes but also with brain, therefore the full statement of the physiological mechanism of vision would include not only the sensitive retinal surface and the visual areas of the cortex but the whole system which includes retina, optic nerve, visual area of the cerebral cortex and other sensory areas of the brain as well.

The problem of vision can be studied by considering only the activity of the retina to the neglect of other factors. This is the view that is generally found in the work of Helmoholtz and his followers. They proceeded on the assumption that the essential process of vision is the formation of an optical image on the retina and its transmission to the visual centres of the brain by means of the optic nerve. Differences between the sensations transmitted to the brain and the finished perception which appears in experience were attributed to the action of the higher processes of judgment and the influence of past experience. The 'transmission theory' of vision has no doubt enriched the sensory physiology of the retina but it left most of the field of perception untouched.

Although the way was paved for the criticism of transmission theory, the real attack did not begin until the publication of Wertheimer's research on 'phi-movement' in 1912. That the transmission theory is not adequate to explain the phenomena of vision can be seen from a very simple experiment. We place on a table an elliptical object with its long axis pointing directly to and from the observer. If his head is directly above the object, it will, of course, look elliptical. If now he moves his head from the position directly above, but still keeping it in the vertical place passing through the long axis, the object will at first look elliptical, but with a smaller apparent elongation than when it is viewed from directly above. If the head is now lowered, but still kept in the same plane, the apparent shape of the object becomes more and more a circle. It then becomes truly circular and if the head is still further lowered, the object appears elliptical again only now with the really longer axis apparently the shorter. The height at which the ellipse looks circular, it is found that the retinal image is not of a circle but of an ellipse with the vertical axis much shorter than the horizontal, that is, an ellipse flattened in the opposite direction. It is as if the shape that is seen (phenomenal shape) is in between the real physical shape of the ellipse and the shape that is projected on the retina (the stimulus shape).

The arguments put forward in support of the transmission theory are untenable. Likewise, the

statement that an object can be seen in its stimulus character by adopting a special 'critical' attitude is wrong and untenable. Experimental data show that the visual characteristic of an object is not a product only of the corresponding local stimulation of the retina or of a projection of this local stimulation on the corresponding area of the visual cortex but the product of the combined action of the different activities of the visual cortex. Further analysis proves that not only do various parts of the visual cortex contribute to the visual appearance of the particular object but other sensory areas of the cerebral cortex also contributes. This hypothesis can well explain the phenomena of size-weight illusion. The research shows that the exact height at which each subject reports the ellipse as looking circular is somewhat variable and may depend to some extent on his mental attitude, but the limits within which variation occurs in any one individual are small compared with the differences between different individuals. In the case of an individual the apparent shape of an inclined object to its real shape remains more or less constant and a correlation as high as 0·92 was found when two sets of tests were given at an interval of two years. Similarly persons who have a tendency to see real size of an object tend also to have a tendency to see the real shape and the real whiteness. The correlation between these tendencies are found to be above 0.6.

Experimental facts prove that for a given individual the apparent size of an object (*i.e.*, disc) decreases as the distance becomes greater. A relation between phenomenal and stimulus linear dimensions of an object at different distances has been found which can be expressed by the equation $P=a+bS$, that is to say for any one individual under uniform conditions of observation, the apparent linear dimensions of an object at different distances change as if they were made up of the sum of two parts, one of which remains constant at all distances while the other is inversely proportional to the distance. The above relations hold good up to a distance of 10 m. meters. Exception to this law has been noted but the case is rare. It has also been found that the tendency to phenomenal regression increases with age. Phenomenal regression to real colour is also reported to have been observed in fishes and in chicks of three months old.

On the practical side of phenomenal regression, it can be said that a person with high phenomenal regression can drive cars more easily through a traffic. This fact corroborates the findings of the National Institute of Industrial Psychology. The phenomenal regression is affected by certain drugs, *e.g.*, alcohol decreases it while caffeine increases it.

In conclusion it can be said that psychological study of vision has undergone a change during the last 25 years. Vision is no longer considered as a function of the eye alone but of the eye and higher centres, that is to say the psychology of vision is not the sensory physiology of the eye.

A. N. D.

Educational Science

The Function of Administration in Public Education

—J. Sargent

Mr Sargent believes that the administrative machine, particularly in the public education service, is an instrument which, if improperly employed, may distort experimentation and hamper research into method. This impact of administration on education is the subject of his review.

"Political thinkers throughout the ages have frequently defined or described the function of administration. Of all their attempts the one which appeals most to a harassed official is the late Lord Fisher's cynical aphorism that it consists in the intelligent anticipation of agitation. From a somewhat less negative point of view it may be regarded as compounded of deliberation and execution, of which the latter should but does not always follow the former......Until 100 years ago the main interest of government was to restrain men from living evil lives; since then the intention, however mysterious in operation, has been to help them to live good ones."

"But if devolution is to remain a necesssity, and granted the continuance both of a democratic system and of the parental interest of the State, there seems no alternative. The really disconcerting problems for the future seem to me to arise from the present nature of the local government bodies themselves. The first difficulty would appear to lie in the unit, *i.e.*, in the size and geographical distribution of local government areas. Recognised authorities, who are mostly foreigners and seem to regard our political institutions with greater enthusiasm than we do ourselves, tend to congratulate us on our ingenuity in adjusting them to meet new social and economic needs as they arise. It would be difficult to detect this evolutionary process at work so far as local government boundaries are concerned."

Amateur Versus Professional Elements

Dealing with the question of amateur versus professional personnel of the Local Education Authorities, Mr Sargent writes:

"The most serious aspect of the problem to my mind is the steady and even accelerating deterioration in the amateur personnel which has taken place since the War. This is particularly marked in the case of the elected representatives of the people. The reasons are as plain as the fact. The most obvious of course is the gap caused by the War itself in the ranks of those who, if they had survived, would probably have been the first to offer themselves for public service. But this is by no means the whole or even the main explanation. The vast increase in the responsibilities laid upon local authorities by legislation since the same period makes it necessary that any member who is to become really *au fait* with the business of education should be able to devote a considerable amount of his weekly time to it, whereas before the War it was possible for a person of average intelligence to grasp not only the general lines of policy but also day-to-day happenings by occassional attendance at committee meetings."

Mr Sargent notes the "increasing tendency of Education Authorities to consist of people who have retired from work, or have never had work, or who are in fact professionals rather than amateurs because, as officials of political or other associations, it is expedient for them to become members of Local Education Authorities from the point of view of promoting the objects which their associations have at heart. It is no reflection on the personal integrity of these last to express the opinion that they constitute a serious danger to the system on the ground that if there is a bureaucratic habit of mind, and if as some people believe it is inimical to good government, these people possess it and bring it to bear on their consideration of educational problems without the saving grace of the professional educationist's training in and knowledge of the particular branch of administration with which he is dealing."

He objects to this development because of the risk "which is more than theoretical, of intellectual dishonesty creeping into the discussion of educational affairs when the Authority contains any substantial number of members who are pledged to a set of opinions which may have a cross-bearing on purely educational considerations."

B. N. B.

Geography

Correlation and Culture

—Griffith Taylor

THE importance of geography in the realm of general education, its correlation with history, culture etc., were among the problems discussed by Prof. Griffith Taylor in his presidential address delivered before the Geographical Section of the British Association for the Advancement Science, Cambridge, 1938.

The feature of geography which gives it a special place in a general education is, according to Taylor, that it is too wide-spread in its interests to fit into any rigid division of disciplines, *viz.*, the Physical, Biological and Social Scienc.s and the Humanities.

It links up the environmental sciences of Geology, Physics, Astronomy and Botany with the human Sciences of History, Anthropology, Sociology and Economics. The techniques learnt in the realms of Geography, Biology and Geology may be carried across to Anthropology, History and Sociology. Geography is defined as a discipline concerned with the description, localization and explanation of the data which relate man to his material environment.

Localization or charting the data being the essential feature of Geography, the speaker, following Huntington deplores that many historians regard a court intrigue as more important than the influence of climate, relief, occupations, *etc.*, upon national character or upon specific historical situations. Many economic historians seem to know little about how the geographic environment influences not only the available resources, but also man's desires and the energy with which he works to satisfy them.

According to Matthew the cradle-land stages of evolution of various related groups of higher mammals can be deduced wholly from their distribution in time and space, the marginal forms representing the older stages of evolution, while the latest forms occupy the centre. This constitutes the Zones and Strata phenomena. The Salient Control of the environmental stimulus centred in South-Central Asia was responsible for the vast biological changes involved in changing something like an antelope to a sheep. This stimulus persisted in the same region from early Tertiary times to about 10,000 B.C., when the first stable civilized communities of man developed. The different racial groups of man must have originated in the same region in about half a million years. The major culture-changes are also essentially responses to environment--only far more rapid than biological changes. The same region of high stimulus must have witnessed the development of man from the nomadic hunter to the settled village-dweller.

Whereas the Alpine, Mediterranean and Australoid races are generally held to have originated in Central Asia, the author, led by the marginal distribution of the Negroes and Negritos assumes a similar origin for them. Thrust out from the cradle-land by climatic changes, they migrated mainly to Africa, which was easy of access, and partly to Melanesia by circumventing the mountains of South-East Asia, across the East-Indies, probably using the alternately open and drowned corridors of the Sunda and Sahul lands. The next drift was towards Australia. Migrations to America must have passed *via* North-East Siberia, during warmer interglacials when the Behring route was feasible, and included the Australoids, and Eskimos. The Alpine-mongoloids migrated into the New World at a time when the American corridor was available.

Diagrammatically illustrating the movement of ice-caps in Scandinavia, the author shows how about 18,500 B.C. Sweden lay under the ice-cap, while Tundra plants were growing in north Germany and Denmark. About 9,000 B.C., the ice-front retreated northward halfway along Sweden. At this time fir trees were growing and neolithic man appeared in Germany, though not on the Baltic. About 4,000 B.C. the ice retreated further north, and the fir covered Scandinavia. Along with the oak, the higher culture of bronze tools appeared in North Germany. At the dawn of history modern conditions came to prevail; the beech became the dominant tree on the Baltic and the Iron-age man appeared. Charting the distribution of human races before the period of modern migrations, the author shows that all the progressive nations of the world are built up of the same three stocks, *viz.*, Alpine, Nordic and Mediterranean. Differences like those separating the Europeans, Japanese, Chinese, Indians, Polynesians and Amerinds have been smoothed away in European Soil by their component stocks in Neolithic times. But a real racial barrier being much more difficult to overcome than cultural differences, it would take a long time for the Negro problem to be solved.

A common language is often the chief cement, linking the various races and cults to form a nation. The main language groups with their inter-relations constitute an evolving complex arising in South-Central Asia and affected by wide migrations, the marginal languages being the earliest. In the Occidental area the languages evolved in the following order:—the agglutinative Bantu and Turkish, the amalgamating Hamitic-Semetic, Basque, Sumerian, and the infectional Aryan with its three subdivisions,—the *Kentum*, the P and the *Satem* languages. The study of the latter by stage diagrams correlates our scanty knowledge as to the early wave-fronts of the Aryan languages and shows how they spread towards India, Persia and Europe.

Aryan is now spoken by Alpines in Central Europe, by Nordics in the north and Mediterraneans in the south. It may be assumed that originally each of these races had a distinct culture and language. Who then, were the first Aryan speakers? It is suggested that the marginal Mediterraneans of South and West Europe orginally spoke Hamitic before being conquered by the Aryan speakers. On the northern margin of the Aryan realm, where the Nordics dwell, there are the Altaic speaking Finns, many of whom are Nordic, like some north-Asiatics as the Altaic speaking Ostiaks of the Yenesei. The Altaic languages seem to have been pushed to the margin by later Aryan speeches. The Teutonic group of Aryan has certain resemblances with the speech of the Finns and the Ostiaks. Hence it is suggested that the Nordics of Germany and Scandinavia originally spoke Altaic and later adopted Aryan.

The Basque, a non-aryan language, has some affinities with Abkasian in the Caucasus, Altaic and some Amerind tongues. Peake suggests that the earliest Aryan tongues were introduced into Europe by the Alpine race from Asia about 1,500 B.C. Some four millenia before this, the Alpines were represented among the Danubians and at Ofuet. The author believes that the Amerinds who were pouring into N. America about this time were of much the same race as the Alpines. The Pre-Gaelic Alpine invaders of Europe were of the same linguistic zone and spoke Baskue. Subsequently the pre-Aryan language made room for Aryan, leaving relics like Abkasian.

The graphs of culture-growth help to create a mental picture of the processes involved in culture spreads. Stage diagrams illustrating the growth of a city like Chicago show how it resembles a cone, starting at the humble houses of the original settlement and expanding with passage of time. This phenomenon is comparable to a series of concentric craters built by the lavas in a gradually increasing volcano, each lava-flow covering part of the preceding flow and pushing some of the earlier lava to the periphery. Such " Craters of Growth " help us in our search for affinities of isolated tribes, speeches and cultures, and are used by the author for studying the racial and linguistic distribution.

During the twentieth century Geography has trended away from the belief of Ritter in Providential control and from Environmental control as expounded by Ratzel, towards the possibilistic theory of Vidal de la Blanche, according to which our material evolution depends on which of the possibilities we choose. His experiences in Canada and Australia where the possibilities offered by Nature are more meagre than in Britain or U. S. A. incline the author to the second or geocratic view. Illustrating the industrial development in Canada, he shows how fishing, farming and fur were confined about 1750 to the east. By 1810 farming had extended to Detroit while Mackenzie was exploiting the Mackenzie river-basin for furs. In 1870, gold silver and iron mines were being exploited near the St. Lawrence and on the Fraser river. About 1880 began the migration to the wheat-fields of the prairies. Since then modern conditions have come to prevail. As wheat grows only under favourable conditions, all the fur country could not be utilised for wheat. Hence man has not been a free agent in all this evolution. He can only accelerate, slow or halt a country's evolution, but does not alter its direction. The evolution of present social groups in Europe depend very slightly on national or tribal characteristics, but is almost wholly determined by the environmental controls of climate, topography and coal.

Culture in the Twentieth Century

Our education is still a battleground between conservatives and liberals. Interests in the classical literature of a bygone age are still powerful in conservative school, college and university education. Since most cultured folk receive the main part of their education in the years from fourteen to twenty-two, these years must be wisely spent. Our youth must be trained to deal scientifically with existing conditions. Besides the specialised knowledge needed for a profession, education should include Biology, History and Geography. The attention of youth for a generation or two should be directed away from Physical Science to the difficult problems of Social Science, *e.g.*, Communism, Socialism, Judaism, Nordicism etc,—creeds which are cultural facts and more vital to the man of culture than a conservative education based on art, music or classic.

A. M.

Conference of Delegates of Corresponding Societies

The Importance of National parks in the preservation of the Fauna of Great Britain

—The Rt. Hon. the Earl of Onslow

THE Rt. Hon. the Earl of Onslow who presided over the Conference delivered an address on the "Importance of National Parks in the Preservation of the Fauna of Great Britain." In defining the term 'National Park' he referred to Article 2 of the Convention for the Protection of the Fauna and Flora of Africa held in London in 1934 (quoted below) and clearly distinguished the term as understood in Great Britain and in other countries.

ARTICLE 2

"1. The expression 'national park' shall denote an area (a) placed under public control, the boundaries of which shall not be altered or any portion be capable of alienation except by the competent legislative authority, (b) set aside for the propagation, protection and preservation of wild animal life and wild vegetation, and for the preservation of objects of aesthetic, geological, pre-historic, historical, archaelogical, or other scientific interest for the benefit, advantage, and enjoyment of the general public, (c) in which the hunting, killing or capturing of fauna and the destruction or collection of flora is prohibited except by or under the direction or control of the park authorities."

"In accordance with the above provisions facilities shall, so far as possible, be given to the general public for observing the fauna and flora in national parks."

"2. The term 'strict natural reserve' shall denote an area placed under public control, throughout which any form of hunting or fishing, any undertakings connected with forestry, agriculture, or mining, any excavations or prospecting, drilling, levelling of the ground, or construction, any work involving the alteration of the configuration of the soil or the character of the vegetation, any act likely to harm or disturb the fauna or flora, and the introduction of any species of fauna and flora, whether indigenous or imported, wild or domesticated, shall be strictly forbidden; which it shall be forbidden to enter, traverse, or camp in without a special written permit from the competent authorities; and in which scientific investigations may only be undertaken by permission of those authorities."

"3. The expression 'animal' or 'species' shall denote all vertebrates and invertebrates (including non-edible fish, but not including edible fish except in a national park or strict natural reserve), their nests, eggs, egg-shells, skins, and plumage."

The African Powers recognised two types of preservation of the fauna: (i) by the establishment of National Parks intended to afford as much access as possible to the general public; (ii) by the establishment of Natural Reserves intended for scientific purposes and, therefore, not open to the public except under very definite restrictions. The applicability of the African Convention to the utilisation of National Parks of Great Britain was examined by him in detail. The Standing Committee on National Parks of the Council for the Preservation of Rural England and Wales laid down the policy that Government should declared that the establishment of National Parks is an essential national service and should set up two National Parks Commissions, one for England and Wales and the other for Scotland, with a joint committee co-ordinating the two, and provide funds.

The principle of the establishment of a National Park devoted mainly to the preservation or our fauna has been adopted by a number of authoritive Societies interested in the matter. The President suggested that the thousands of acres of deer forest on the West coast of Scotland would be the most suitable in Great Britain for the creation of the National Park, and discussed in detail and from various points of view why such a Park should be in deer forest and not contiguous to grouse ground, and how the three species of deer—red, roe, and fallow deer—can be kept under check. It is essential in a Park to keep sufficient deer to be visible to the public in their native haunts, and to shoot poorer animals and older stags and hinds, sparing the big stags with the good heads. He thought also that

National Parks could very well be utilised for the preservation of the stock of various other species of animals such as wild cattle and goats, foxes, badgers, stoats, weasels and others. Some species which are becoming rare as the wild cat, the pole cat, and the pine marten which live in woodland country might also be afforded adequate protection in the National Parks. The preservation of rodents in the northern climate might not prove as difficult as that of the rarer bats which are restricted to the South of England.

The National Park might also be made to serve as a strict Bird Sanctuary, and if at least a part of the Park is close to the sea the breeding of sea birds could be encouraged.

The President next discussed the question whether it would be desirable in a National Park to attempt to acclimatise animals which have become extinct in Great Britain. The elk which became extinct in pre-historic times might not do well if reintroduced, but the reindeer, the wild pig and the beaver which became extinct only in the last few centuries might profitably be reintroduced. The only difficulty would be in regard to the right type of food to feed them with in Scotland. But he would, however, be on the side of caution in regard to the whole question of the introduction of species which have become extinct. Exception might be made of the Irish stoat which is a denizen of the British Isles or of the lemmings, but the case of the musk rat and the grey squirrel which proved to be a nuisance should make one very careful about the introduction of species of foreign origin.

The address next dealt with the difficult questions of finance and management of the National Park. Forest country in Scotland was a good deal cheaper than it used to be, and it should not be impossible to acquire with the aid of Government or by means of public subscription a large area of forest land. A National Park would not be as expensive to the nation as a deer forest to the rich man, for there would be a steady income as in the case of the National Kruger Park of South Africa. A hotel or rest-house which would maintain itself, roads and footpaths to enable people to get about and see the animals, a staff of keepers, pony men, dog men, and watchers to keep the animals within bounds, ward off poachers, and to prevent sightseers disturbing the sanctuary are all that would be needed for the efficient management of the National Park.

In regard to the management of the property in Scotland housing the National Park the address referred to the ideas put forward by Sir Peter Chalmers Mitchell. According to him the popular functions of the National Park would be entrusted to delegates appointed by Edinburgh, Glasgow, Dundee and Aberdeen, working with delegates appointed by the Council of the Counties in which the Park was situated. The Governing Body of the National Park would include a panel of naturalists interested in Botany, Zoology, and two field naturalists with special knowledge of plants and birds. The members of this panel might be selected by the Principals of the four Scottish Universities and by the Presidents of the Royal Society of Edinburgh and of the Highland and Agricultural Society. Apart from the staff concerned with the general regulation of the Park, the scheme contemplates the appointment of a warden or ranger chosen by the panel of Naturalists, whose sole duty should be the constant study of wild life in the Park and all its fluctuations.

H. S. R.

[Abstracts of the Presidential Addresses of the Botany and Zoology Sections are to appear in the next issue.]

Zoology

Oceanography and the Fluctuations in the Abundance of Marine Animals.

Stanley Kemp.

Oceanography is the science of the sea. It includes physico-chemical work, coastal surveys, soundings and studies of tides and currents, marine zoology and botany with some geology and even meteorology.

Modern oceanography really began about 70 years ago with the establishment of the first marine biological station at Naples. Since then numerous marine expeditions by specially equipped research vessels, as well as geographical and other expeditions have given us much knowledge about the oceans. But oceanic expeditions must be supplemented by lengthy and detailed studies in biological stations and in many parts of the world these facilities are quite inadequate. Observations on other faunas are now essential to further progress, and a well-equipped tropical station in one of the richest areas of the Indo-Pacific region is an urgent necessity.

State Fishery Laboratories by their intensive studies have given us complete, or almost complete, accounts of the natural history of a number of fishes with detailed information far beyond what we possess for any other marine organism. To acquire this knowledge is a long and arduous task and as yet is by no means finished. The application of scientific methods is showing the way in which stocks of fish can be utilized to the best advantage, and the success of fishery prediction must have struck even the most casual observer.

The rapid progress in oceanography is thus due to these three agencies: to the expeditions, the marine stations and the fishery departments.

A most important feature of animal life in the sea is the constant occurrence of large variations in abundance, which, though possibly not greater, appear to be more general in their incidence than in land animals.

The great annual fluctuations in the abundance of a fish fish belonging to one year class may be fifty times as numerous as those of another—are mostly attributable to events which happened in the early months of the fish's life; and there is good reason to hope that with improved knowledge of the spawning areas and of the environmental factors during the critical period the causes of these annual fluctuations will in due course be discovered.

It is becoming apparent, however, that there are other over-riding influences at work, which not only affect the abundance of marine animals, but may bring about great changes in their distribution. There have been very marked changes in the western half of the Channel during the past seven or eight years and the evidence points to the existence of long-period fluctuations which are superposed upon the normal annual fluctuations.

Mr F. S. Russell has found that in the Plymouth area from 1931 onwards there has been an alarming decrease in the abundance of larval fish of all species.

This change is apparent in the Plymouth herring fishery, which is now virtually non-existent. Table I gives the returns of the fleet of steam drifters from Lowestoft which annually visit Plymouth in the winter.

The significant point in this Table is the marked change in the composition of the catch which began in 1931-32 the winter of the year in which the summer spawning fish larvae showed their first signs of decline. Prior to 1931-32 herring, not more than six years old, always formed at least two-thirds of the catch. In that season the younger fish were only 52 per cent of the total while to-day there are less than 20 per cent of the younger and more than 80 per cent of the older.

This change was not immediately reflected in the size of the catches on account of the considerable stocks of older fish. But as these passed out they were not replaced by any adequate numbers of the younger year classes. The number of

Lowestoft drifters which visit Plymouth for the herring season has fallen from over 100 to only one in the last season and the weight of fish landed from 80,000 cwt. to under 30 cwt.

TABLE I

Season (Dec.-Jan.)	Weight landed in cwt.	Number of steamers.	Average weight per landing in cwt.	Percentage composition of catch by age. 6 years and under.	Over 6 years.
1924-25	83,600	86	40	91	9
1925-26	82,800	153	23	82	18
1926-27	45,900	129	17	66	34
1927-28	82,800	77	46	83	17
1928-29	42,200	81	27.5	81	19
1929-30	34,300	54	39	71	29
1930-31	44,100	75	33	72	28
1931-32	21,000	52	18	52	48
1932-33	47,800	85	34	35	65
1933-34	29,780	85	30	35	65
1934-35	46,600	91	28	25	75
1935-36	33,800	105	16	<20	>80
1936-37	1,700	56	6	<20	>80
1937-38	28½	1	9.5	..	..

The stock of herring on the north coast of Donegal shows a pronounced decline which began in 1930, some eighteen months before the change in the constitution of the Plymouth shoals was first seen, and the industry based on this fishery has suffered greatly. Conditions at Plymouth and on the Donegal coast are not identical, and the annual fluctuations have thus not operated in exactly the same way. But the shortage of herring in recent years has been accompanied, just as at Plymouth, by a great reduction in the numbers of the earlier year classes, and it is thus possible that the same long period fluctuation is affecting both areas.

Since 1931 there has been a marked change in the amount of phosphate in the offshore waters. Records show that the phosphate is at its maximum in December and January. The phytoplankton crop is limited by the amount of phosphate in the water, so the winter records indicate the quantity of food which will be available for fish larvae, and as seen in Table II, there is an evident relation between the amount of phosphate and the abundance six months later of the larvae of summer spawning fish. Comparing the two four-year periods we find that the decrease has been about 35 per cent. The fact that the larvae of summer spawning fish were the first to feel the adverse conditions and that those of the spring spawning fish were not seriously affected until 1935, can, in thory at least, be explained in terms of nutrient salts; a reduced crop of phytoplankton means a smaller supply of zooplankton which will mostly be consumed by the spring larvae, leaving little or none for those that come later in the year.

TABLE II

Year.	Phosphate in preceding winter % deviation from mean.	Young fish (less Clupeoids)? Summer Spawners.	Spring Spawners.	Total No. 1000.	*Sagitta.* S. elegans. %	S. setosa. %
1922	> +16	..	..	..	..	..
1923	> +27	..	..	..	..	..
1924	+27	696	2,133	..	..	..
1925	+9	140	1,510	..	..	..
1926	+36	909	2,051	..	..	..
1927	−2	170	1,014	..	..	..
1928	+23	..	..	..	..	..
1929	+23	321	502	..	..	..
1930	..	403	1,114	91.5	94.1	5.9
1931	−7	230	1,395	117.3	16.7	83.3
1932	−16	197	1,359	118.3	6.2	93.8
1933	−5	117	1,220	117.4	4.7	95.3
1934	−14	79	1,065	94.5	3.5	96.5
1935	−25	37	393	48.2	3.6	96.4
1936	−16	115	372	24.0	39.7	60.3
1937	−14	174	..	26.1	3.8	96.2
1938	16	..	786	..	..	..

Renewal of the phosphate in the Channel appears to be largely dependent on an inflow of mixed Atlantic water, rich in phosphate; and the normal water movements off the mouth of the Channel have apparently undergone marked alteration in recent years. Direct proof is lacking, but evidence is afforded by the discovery that certain planktonic species may be used as indicators of water-masses, particularly *Sagitta* species.

We thus have evidence from four separate sources of the changed conditions which have prevailed in the Channel since 1930-31. These sources are (*i*) the winter phosphate maximum; (*ii*) the numbers of fish larvae; (*iii*) the constitution of the spawning herring shoals; and (*iv*) the predominance of one or other species of *Sagitta.*

The view that this large alteration is linked with hydrographical changes is corroborated by continuous records of the currents in the Straits of Dover made with the Carruthers drift indicator. Water can enter the North Sea both from the English Channel and round the north of Scotland and Dr Carruthers infers that these water masses are opposed to one another and act in a sort of 'buffer relationship.' At the Varne Lightship the relative strengths of these two forces are indicated by a change in the direction of the current. Dr Carruthers has calculated the direction of the residual current for each year since 1926 and his figures show that from 1931 onwards this residual current has swung towards the north and has considerably less of the easterly component which is possessed in the earlier years when high winter values for phosphate were observed at Plymouth.

We may suppose that this long-period fluctuation at the mouth of the Channel will end in due course, but we have no means of knowing when this will happen. When the change comes it will be heralded, we believe, by the return of *Sagitta elegans* in large numbers, and by a marked increase in the winter phosphate maximum. The fisherman will presumably not find any immediate improvement in the bottom fish, and when better conditions return he must wait until the increased numbers of larvae grow to fish of marketable size.

Records of the temperature and salinity changes at the western end of the Channel show large periodical incursions of low salinity water while at other periods patches of unusually high salinity moved eastwards up the Channel. However, only the phosphate data show any correlation with the marked biological changes.

In 1921 an exceptional influx of Atlantic water filled the Channel and flooded into the North Sea. Salinity and temperature were much above normal and numbers of unusual planktonic organisms of Atlantic origin appeared in the North Sea. One might think that such an influx as this would benefit the herring fisheries, but actually at Plymouth, at Lowestoft, Yarmouth, Grimsby and North Shields, the herring fishery was much below normal.

Thus incursions of Atlantic water into the Channel may be detrimental to the biology of the area, or they may be advantageous by bringing phosphates and other nutrient salts. Even if deficient in phosphate they may bring large quantities of plankton providing immediate food for larval fish.

Thus what we may call the biological condition of the water is the important factor and this, no doubt, is to some extent determined by the season of the year. But it is perhaps more probable that upwelled water, rich in the nutrient salts which are always to be found in the lower layers of the ocean, is the potent source of surface enrichment, and of the conditions in which such upwelling occurs we are very largely ignorant. We lack the necessary data and can merely speculate on what may be happening from analogy with what is known in other areas.

Some thirty years ago Mr D. J. Matthews showed that to the south of Ireland there is an extensive cyclonic or counter-clockwise circulation, and he suggested that this might prove of considerable biological importance. 'If the strength of the cyclonic system varies from year to year, so will the character of the water at any place within its influence, such as the areas of the drift-net fishing off the mouth of the English Channel and off the the south coasts of Ireland.'

These events in the Plymouth area together with evidence from other sources show that major alterations extending over a long term of years are by no means unusual, though the hydrographical changes, to which they may be due, may not always be the same.

The fluctuations of the cod fisheries on the Bear Island banks and off the West Greenland Coast are instances to which others might be added. The present profitable fisheries in both areas were preceded by a period of years in which careful testing of the banks yielded very few cod, while early records show that cod had been very plentiful in previous years. All these changes are apparently due to the same cause - in recent years the entire area from Greenland to Bear Island has become appreciably warmer.

An increased sea temperature, possibly 1.0°C to 2.0°C, has allowed various species of fish to extend beyond the normal limits of their distribution so that productive fisheries have appeared in areas which formerly would not have yielded an adequate return. At some future date conditions will probably revert to normal and a time will come when these lucrative fisheries will cease to exist.

Since the only source from which warm water can come is the Atlantic drift, in recent years this

drift must either have increased in volume or in the temperature of the water it carries.

It is believed there are two distinct kinds of fluctuations, both having a pronounced effect on marine fauna. Normal annual fluctuations form the basis of fishery predictions and we believe their causes though our knowledge of these is small—as well as their incidence, to be restricted both in space and time.

In contrast, are the long-period fluctuations, which extend over a term of years and involve much larger areas. They may mask the effects of the annual fluctuations and at times render fishery prediction unreliable.

The evidence indicates that long-period fluctuations may be brought about in entirely different ways. In the Channel, apparently, the change can be traced to a deficiency in phosphate, while in more northerly areas it is due to an increase in sea-temperature. But, though there is this wide difference, the two sets of circumstances have this in common that they originate in the open Atlantic at the edge of the continental slope or farther to the west. It is here, in oceanic waters, that the causes of these large alterations in European fisheries must be sought.

Three mutually conflicting theories are extant regarding the circulation of water in the North Atlantic, but a beginning has been made in the study of the hydrography of the North Atlantic by American, British and Continental scientists. Comparable data are necessary from our own waters if the work is not to lose much of its value.

In conclusion Dr Kemp calls attention to the urgent need, throughout a very large part of the British Empire, for greater activity in the scientific administration of the fisheries, for to himself, at least, it is apparent that the lessons which long years of experience have taught him and others in England are not generally understood elsewhere.

The plain fact is that in the Empire as a whole we are deplorably deficient in fisheries administration. To this broad statement there are of course some exceptions such as the Irish Free State, Canada and Newfoundland, and colonies such as the Straits Settlements and Ceylon. Australia has at last taken the wise step of founding a Commonwealth fishery department. In South Africa the fishery staff is utterly inadequate, and in India, where fisheries research has immense possibilities, there is apparently little hope that proper action will ever be taken. In India fisheries have been handed over by the Central Government to the provincial administrations. Consequently some provinces may have a scientific staff of one, others none at all, while Madras, which is much the most enterprising and publishes a Fisheries Bulletin, has three. In such conditions fishery work on any adequate scale is clearly out of the question and it is not possible even to begin the acquisition of the fundamental knowledge that is essential to future progress. Japanese trawlers, taking advantage of the complete lack of development of the Indian off-shore fisheries, are now visiting the Bay of Bengal in increasing numbers, and there is perhaps a possibility that their activities will cause the Government of India to realise how backward they are in fishery administration. It is evident that little or nothing can be expected from one or two men working in isolation and that only an all-India service, with the *esprit de corps* that such a service would have, can be sufficient for India's growing needs.

It has taken more than a quarter of a century of intensive co-operative effort by most of the leading European nations to build up the information that we now possess of the fisheries round our coasts. Yet our information is not within sight of being complete. But we have made a beginning and are aware of the deficiencies. Administrators are still prone to expect a rapid solution to any question which they submit to scientific inquiry, but in almost every problem which touches marine biology it is essential to possess a background of fundamental knowledge which can only be acquired by long years of patient study.

In many other parts of the world, however, not even a beginning has yet been made. Throughout almost the whole of the vast stretch of the Indo-Pacific region there is scarcely a fish whose life history is fully known. Of such matters as age, rate of growth, spawning periods, food and migrations, the incidence of fluctuations, seasonal or other changes in the environment, nothing is known. It is surely high time that the importance of such knowledge is recognised and that early steps are taken to lay the foundations of fishery science throughout the Empire.

—*B. S. K.*

The General Physiology of the Plant Cell and its Importance in Pure and Applied Botany

—Prof. W. Stiles

STARTING from the time when the cellular structure of plant and the relation of protoplasm to life were known the address has dealt with the progress of the knowledge of protoplasmic properties of plant respiration and salt absorption.

Respiration, absorption and excretion of water and dissolved substances are the properties of living plants for an understanding of which a knowledge of protoplasm and the cell system in which these physiological processes are taking place is essential. It has been long realized that the functioning of plant machine depends on the harmonious working of all plant activities. Since such activities are controlled by protoplasm, a study of physical and chemical constitution of that substance had been undertaken to connect the passage into and out from the cell of water and dissolved substances with the existence of an external protoplasmic layer, chemically different from the inner part of cytoplasm. The presence of vacuolated cell and protoplasm are the necessary conditions on which salt absorption is dependent since any disturbance in them leads to the alteration of water relations of plant cell. In respiratory process the function of the protoplasmic mass is to supply the necessary enzymes.

Although protoplasm is the basis of multiple activities, the structure of it has been till now a matter of diverse conjecture; but intrinsic difference of protoplasm of one object from that of another is very evident. All that is known of protoplasm is that it presents a system with a large internal surface in which there are various phases of different chemical composition. One of the characteristic features of such a system is that it is continually absorbing oxygen and giving out carbon dioxide. Since this process involves the loss of material from the protoplasmic complex a tendency to replace that loss in the movement of materials into the cell links up the process of respiration in plants to absorption of dissolved substances. From the time of Sach the fundamental idea of respiration in respect of gas exchange with the outside atmosphere and its importance on the physiology of cell were known, but the actual mechanism of the oxidation of sugars and fats was not considered by the workers during that time. Later in the last part of the 19th century Russian investigators, notably Palladin and Kostychev, made some important contribution to the knowledge of plant respiration. The importance of enzymes in animal respiration has been worked out to a great extent, but attempts to elucidate the role of enzymes in plant respiration have succeeded no further than to rely on speculations of several possiblities of enzymatic reaction. Through respiration energy is supplied and that may be either needed for the continuation of life in a cell or used up for building up complex plant substances. In assigning a function to respiration conclusions by pioneer workers on respiration depend on the supply of kinetic energy of all physiological processes, the sum total of which is in the manifestation of growth such as flowering, fruit formation, vegetative propagation, etc. Apart from these actively growing organs there are structures which are in a senescent or resting condition such as seeds, mature fruits and tubers; which also no doubt liberate CO_2 and absorb O_2. A simple function of respiration to supply energy for constructive processes possibly is not sufficient to explain the behaviour of gas exchange in such storage and senescent organs where an absence of processes connected with syntheses is predominant. Respiration in them seems to be connected with the maintenance of protoplasm in living condition.

The outstanding problem of respiration that awaits solution is the mechanism by which energy is released through the oxidation of sugars and fats. It involves the determination of the course of the breakdown of sugar into CO_2 and H_2O, and the necessary enzymes concerned in the process. The assumption is generally made that the breakdown of sugar follows the same course in its earlier stages as in fermentation by yeast, in which according to the scheme of Neuberg, Embden and Meyerhoff, pyruvic acid $CH_3CO.COOH$ is an intermediate product in which the zymase complex plays a leading part. Then under the influence of enzyme

carboxylase, pyruvic acid is decomposed to acetaldehyde and carbon dioxide. Up to this stage the course of breakdown is the same, both in presence and absence of oxygen. Then in later stages, according to the presence or absence of oxygen, the end products differ; in absence of oxygen the products are ethyl alcohol and carbon dioxide; while in presence of oxygen the products of glycolysis appear as carbon dioxide and water. Thus for each molecule of sugar involved in glycolysis only ⅓ of the carbon present in pyruvic acid appears as carbon dioxide under both aerobic and anaerobic condition, while in the latter ⅔ carbon is accounted for the production of ethyl alcohol. The question arises to account for the ⅔ carbon in aerobic respiration since no other products accumulate, nor an increased carbon dioxide production results. An explanation of this was first offered by Wortmann, who first suggested the theory of the synthesis of this ⅔ carbon compounds back into the system. The evidences for such a building back into the system are presented in greater detail by F. F. Blackman. Referring to his well-known works with apples it is evident that the rate of sugar breakdown is enhanced by an increased oxygen supply and this is presumed to be due to the production of increased respiratory substrate. Stiles in investigations on the surface- volume effects in respiration of bulky tissue has noted the same relation; in the middle region of such tissue, owing to the lack of oxygen supply, the production of active substrate is minimum and this explains the lower rate of carbon dioxide production in that region. A rise of respiration rates when apples respiring in air are transferred to nitrogen has been interpreted by F. F. Blackman and Parija to be due to the fact that in air a large amount of some substance is formed along with carbon dioxide and water and this substance is held to be responsible for an initial increase in respiration rates when apples are transferred from air to nitrogen. While in presence of oxygen this substance is built back into the stream of katabolites. Regarding the nature of the substance formed it is not known whether sugar or some other intermediate product is formed. This building back into the system has been termed oxidative anabolism by Blackman, since in absence of oxygen ethyl alcohol appears. The evidence for oxidative anabolism has also been obtained in Stiles' laboratory but it is by no means of general occurrence.

Investigations on the organic acid metabolism of succulents are interesting to throw some light on the problems of respiratory process. Organic acids, notably malic acid, have been isolated in a number of plants. Malic acid is held to be formed as a product of respiration, but opinions differ regarding the actual part played by this acid in the sequence of actions following the breakdown of carbohydrates. Ruhland and his collaborators hold the view that up to the formation of pyruvic acid the same course as in normal respiration is followed, then pyruvic acid instead of decomposing into acetaldehyde undergoes synthesis to diketoadipic acid which then breaks down to succinic acid and formic acid and finally from succinic acid malic acid arises. The presumption is that the course of the reaction is preceded by an accumulation of acetaldehyde which inhibits the activity of carboxylase. Again when the inhibitor is removed, malic acid undergoes oxidation to oxalacetic acid which is then converted to pyruvic acid; then the usual break down of pyruvic acid follows. The latter course of reaction explains the disappearance of malic acid in day time. Bennet Clark has made a criticism of the view on the ground that neither formic acid nor a high concentration of acetaldehyde as to inhibit the carboxylase has been found in succulents. On the other hand, he has shown that for each molecule of sugar respired away only one molecule of malic acid is formed and from the remaining two carbon atoms no other products nor CO_2 appear which suggest that the carbon compounds, formed by glycolysis along with malic acid, must be built back to a polysaccharide. Carbon dioxide under these circumstances does not come out from malic acid but from some intermediate products of glycolysis. The acid metabolism in succulents thus shows the possibility of oxidative anabolism.

The phenomenon of oxidative metabolism linking carbohydrate breakdown to its re-synthesis leads one to enquire about the existence of a similar relation between protein synthesis and carbohydrate breakdown. It is very likely that the products of sugar breakdown might supply the non-nitrogenous parts of protein complex and accordingly oxidative anabolism is to be expected in growing organs having active protein synthesis. The indication of such a re-synthesis in germinating seeds has been obtained in Stiles' laboratory. On the other hand in some germinating seeds apart from any anabolic

process a continual breakdown of protein takes place for about first 10 days with less synthesis of protein in the growing centres and this breakdown of protein in addition to sugar oxidation is possibly related in some way to energy supply. The data at present are not sufficient to formulate a relation between carbohydrate breakdown and oxidative anabolism on the one hand and protein synthesis on the other; further investigations to elucidate this connection are necessary. The existence of a close relationship between anaerobic and aerobic respiration still remains an assumption; contrary to this some different results in respect of end products and enzyme actions have been recorded by Muller and Lundsgaardh which lead them to suggest anaerobic respiration is quite distinct from aerobic respiration. But considering the effect of oxygen on the production of carbon dioxide in equal quantities during both aerobic and anaerobic respiration, the general trend of opinion is to assume a relationship between the two phases of respiration.

The absorption and exeretion of water and dissolved substances were considered to follow the physical laws of osmosis and diffusion and an assumption has been made that the penetrating substance diffuses unchanged through the protoplasm into the vacuole where it still remains unchanged and increases the osmotic pressure of the vacuole approximately in proportion to the amount entered into the cell. The assumption finds support in the absorption of non-electrolytes, but the position becomes different when the entry of electrolytes is considered. Molecules of electrolytes do not enter the cell as such, but diffuse into the cell in the form of their constituent ions. Two ions of an electrolyte are absorbed to different extent by living cells. Since the total positive and negative electric charges must remain equal in the external solution, there might be two consequences of unequal absorption of ions. First, the excess of the more absorbed ions may be accompanied into the tissue by a quantity of one of the constituent ions of water, hydrogen or hydroxyl, whichever is of the opposite sign to the more absorbed. If this is granted, the external medium will be either alkaline or acidic depending on whether the anion or cation is preferentially absorbed; this generally happens when the culture solution becomes acidic or alkaline. In the second place the excess of the more absorbed ions is replaced by diffusion out of the plant by some other ion or ions of the same sign. This interchange of ions on the other hand will tend to keep the medium from becoming either acidic or alkaline in its reaction. A few experiments made by Stiles indicate the ionic exchange in carrot tissue; excess of sodium absorbed from sodium chloride is replaced by an exosmosis of calcium, potassium and magnesium.

Contrary to osmotic relations of plant cells the phenomenon of salt accumulation has been reported by Stiles and other workers. Storage tissue of carrot and potato has been found to absorb salt until the concentration inside the cell far exceeds the concentration outside. Stiles has further shown that this accumulation depends on the concentration of the external solution; with dilute solution the internal sap concentration may be several times greater than the solution outside; while with concentrated solution the sap concentration may be very much less than that outside. As regards the state of the accumulated salt within the cell, he has concluded from the similarity of the absorption of salt with an adsorption phenomenon that protoplasmic particles present adsorbing material on which the absorbed salt lie adsorbed. That adsorption is the first stage in salt absorption and then this is followed by the movement of the salt towards the surface of the vacuole has been also shown by S. C. Brooks. He has obtained some evidence that valonia immersed in sea water containing rubidium chloride accumulates rubidium in the protoplasm for 2 days, after which this cation passes from the protoplasm to both vacuole and external solution.

A number of workers has suggested that the machanism of salt absorption is conditioned by Donnan equilibrium. But the difficulty in a condition of Donnan equilibrium is that the products of the concentration of any pair of oppositely charged ions should be the same on the two sides of a membrane, so that if one ion of a salt is absorbed to such an extent that its concentration is higher inside the cell than outside, the other ion can only be absorbed to a concentration inside the cell which is lower than its concentration outside. Such is not always the case as has been shown by Stiles; storage tissue can absorb both ions of sodium chloride until the concentration of both is higher than that of the same ion outside the tissue.

The possibility that respiration with the production of H and HCO_3 ions in the cell system has an effect in bringing about salt absorption has been

suggested by several workers, notably Briggs and Brooks. In this condition the interchange of ions required by Donnan equilibrium in the replacement of H by cation and HCO_3 by an anion from the external medium will be fulfilled and this process will be continued all the time the cell is respiring. Brooks has emphasized the connection between absorption of salt and the production of H and HCO_3 ions. When a respiring cell is surrounded by a salt solution, KCl, there results an exchange of ions between the cell and external solution. In this exchange of ions protoplasmic proteins, according to Brooks, are supposed to play the part of initial absorption. Protoplasmic proteins are differently ionised; some are positively charged and others carry a negative charge and then from an external solution H-proteinate unites with potassium and chlorine ion with protein-OH. Potassium proteinate and protein chloride thus formed move through the protoplasm until they reach a molecule adjacent to the vacuole, where an exchange of ions takes place with H and HCO_3 ions. Against this view of the direct effect of carbon dioxide production on salt intake by ionic exchange schools of Hoagland and Steward have shown evidences of the failure of cells to accumulate salt in absence of oxygen although carbon dioxide production anaerobically is presumed to be sufficient. Stiles has suggested that this question requires further investigation as the rate of carbon dioxide production anaerobically continues to fall with time, so there may not be sufficient carbon dioxide production when cells are deprived of oxygen.

But, any rate that there is some connection between oxygen supply and salt absorption is beyond doubt; in absence of oxygen exosmosis of electrolytes took place leading to the speedy death of tissues whereas with oxygen absorption continued. Salt accumulation is thus a vital function and depends on the presence of living substance, protoplasm; but on what particular protoplasmic reaction this is dependent is not known. Adsorption, chemical combination with protoplasmic substances and ionic exchange are suggested to be the possibilities since they are adversely affected by an unhealthy condition of protoplasm.

Next the address has discussed the importance of cell physiology in other activities of plant life and its relation to applied Botany. The photosynthetic process depends on the protoplasmic factor or on the enzymes secreted by protoplasm. The translocation of products of photosynthesis is governed by those laws which govern the movement of dissolved substances into and out of living cells. Root absorption of nutrients from the soil is also regulated by the same principles. The edaphic factors in ecology act by root absorption of materials from the soil. Since host and parasitic relations are problems of cell physiology, a close relation between plant physiology and pathology is obvious. Of late in cytological investigations the need of physiological interpretations have often been realised. The physiologist tends to think the cytoplasm all essential for vital activities, while the cytologist is concerned with the nucleus alone. A knowledge of the two, which are intimately united together and are fundamental to life will undoubtedly lead to the better understanding of some problems of genetics.

The economic importance of cell physiology is visualised in agricultural problems of manuring, nutrition, yield, development and reproduction. One of the modern applications of the principles of cell physiology is the great industry of food storage. The problems of food storage are the enzymatic system, vitamin content and the synthesis of complex organic substances and these are all essentially the main concern of the cell and its physiological principles.

—*S. P. A.*

Lahore

The Seat of the next Indian Science Congress

Lahore is the capital of the province of the Punjab and the head-quarters of Lahore district. It is an ancient city and is situated on the eastern (or left) bank of the river Ravi. The river once flowed close by the walls of the Fort (Daulatkhana) and the city, and about the year 1660 threatened its very existence, when a massive embankment extending for some 4 miles along its bank was built. This great engineering achievement proved effectual, and not only was the city saved but the river was diverted two miles towards the north and has ever since shown a tendency to move further northward.

The name Lahore is traditionally connected with Loh, a son of Ram, as Kasur (Kushore), a sister town, is connected with Kush, a younger son of Ram. This name is not peculiar to the capital of the Punjab. There is a Lahore in Afghanistan; another in Peshawar district; another in Hindustan proper; and a Lohar in the Mewar State of Rajputana. A fort called Lohara gave a ruling dynasty to mediaeval Kashmir. The name " Lahore " is a corruption of the name " Lohore." Again " Lohore " is an abbreviation of " Lohawar ". The suffix *Awarn,* with its derivatives *Awar* and *Ore* means a fort, so the name Lahore is a synonym of Lohkot, Lohgarh, Lohpur, or Lohabad.

Date of its Foundation

The exact date of its foundation is impossible to be found, as there is no recorded material available. It is not mentioned in connection with the expedition of Alexander the Great, nor in the Geography of Ptolemy. It seems to be referred to, but not by name, by Huen Tsang, as a great Brahminical city which he passed on his way from Sangla to Jalandhar about 630 A. D. Strange as it may appear, the city of Lahore is not mentioned by Abu-Rihanal-Biruni though he mentions a Province of Lohawar with its capital of Mahdhokor, but Jaipal and his descendants were described as the Rajas of Lahore. If Tod's chronology is to be trusted Lahore existed in the first or second century A.D., when Raja of Lahore, Kanaksen, the founder of the Mewar family, is said to have migrated from Lohkot. This city may well have existed in the first century of the Christian era, and subsequently decayed, but we need not dwell further on conjectures.

However, in the eighth century A.D. struggles commenced between the forces of Islam and Hindustan. After three centuries Lahore was occupied in 1022, when the sovereignty of Hind became extinct, and Lahore was left in the charge of Malik Ayaz, a favourite of Mahmud of Ghazni.

The Mound of Lahore

It is said that Malik Ayaz built the walls and the fortress of Lahore miraculously in a single night and his tomb close to the Taksali Gate is still revered by the Mussalmans as the burial place of the founder of Lahore. There are strong reasons to believe that Hindu Lahore lies buried in the extensive mounds between Mozang and Ichhra, popularly known as the graveyard of Miani Sahib. One of the gates of the modern city is called Lahori Darwaza as it opened in the direction of Hindu Lahore. A careful examination of the mound reveals the fact that it is an artificial mound gradually heaped up by the accummulated rubbish of centuries, and it has lately yielded two stone sculptures of great archaeological value. Both these sculptures are representations of Hindu gods and goddesses, and they were found in a well 50 feet deep in the centre of the mound, which materially confirms the above belief.

History of Lahore

From the date of its occupation by the Ghaznavids till 1798 Lahore is associated with every Muslim dynasty of Northern India from the Ghaznavids to the Mughals, at times as the seat of a provincial government, but always as a place of great strategical importance. In 1798, Zaman Shah of Kabul made it over as a fine to Ranjit Singh, who afterwards founded a kingdom of which it was the capital. It has remained

the capital of the Punjab after the British annexation in 1849.

Historians and poets both of the East and of the West have united in celebrating the greatness and eulogizing the splendours of Lahore. In the 14th century it was a city great among the cities of India, in the 16th century it was "the great resort of people of all nations" and in the 17th century "the magnificence of its palaces, the length of its streets and the height of its buildings compared with those at Agra and Delhi, and as a city it was second to none either in Asia or in Europe with regard to size or population."

Then there came a change. It began to take its downward course with the decline of the Mughal Empire and it crumbled to ruins with the fall of the Mughal dynasty. In the year 1661 A. D. Bernier noticed that "the houses had begun to look dilapidated, and the long busy streets of the city to be disfigured with ruins." When Ranjit Singh occupied it "the ruins of Lahore afforded a melancholy picture of fallen splendour. Here the lofty dwellings and Masjids which, 50 years ago, raised their tops to the sky in pride were crumbling into dust, and hardly any human beings were to be seen among the ruins: all was silence, solitude and gloom." Sir John Lawrence wrote in 1852, "The vicinity of Lahore is an area of several square miles over which extend the ruins of not one but of several successive cities of various years and various dynasties. The surface of this extraordinary plain is diversified by mounds, kilns, bricks, stones, broken masses of masonry, decaying structures, hollows, excavations and all the debris of habitations that have passed away."

The modern history of Lahore is one of steady development and growth. Splendid new buildings have been erected and some of the show places of India today are in Lahore.

Lahore covers an area of some 29 miles, and the distances within its area are considerable. The sights of Lahore are found on both sides of the river. The places of modern interest are mainly on the left bank. On the right bank, at Shahdara, are the three great historic tombs, and the beginnings of a new industrial city.

Shalamar or Shalimar Gardens

The foundations of these world-renowned terraced gardens were laid by Shahjahan. They were completed in 1637 at a cost of six lakhs. Originally there were six compartments, with pavilions, marble buildings, and fountains, tastefully and symmetrically arranged, in the midst of trees and lawns. The first terrace, entitled Faiz Bakhsh, was exclusively reserved for the emperor and the imperial ladies, and contained his sleeping apartments, baths and fountains. It was in this garden that the emperor held his gorgeous Imperial Darbars, and the place was guarded by Tartar and Armenian soldiers. It was death to a man to approach the enclosure walls or peep in. Now it is a very well kept garden: it is a public property and is accessible to all. It is at a distance of about five miles towards the east along the Grand Trunk Road towards Amritsar. It was formerly situated along the banks of the Ravi, and there was an underground passage connecting this pleasure garden with the palace. Between the garden and the palace there was a regular line of gay gardens and pleasure houses which the great nobles had built in imitation of their imperial master. The ruins of some of these old sites of Mughal Lahore are still visible.

The Railway Station

The city is the headquarters of the North Western Railways. The railway station was built in brick at a cost of Rs. 1,57,000 when the railway line was first opened in the Punjab in 1862 between Lahore and Amritsar. It was designed to serve as a fortified place in time of need. The requirements of the railway have outgrown the present buildings, and proposals are on foot for extensions and modifications to meet the growing wants of passenger and goods traffic.

Railway Workshops

The railway workshops are the largest and most uptodate in India and cover an extensive area in continuation of the station yard towards the east between the railway line and the Grand Trunk Road. It will be opened to the visitors of the Science Congress.

The Fort and the Palace

They are situated towards the north of the city. The fort was originally built by the Ghaznavids, but the modern structures are entirely the work of the four Mughal emperors, *viz.*, Akbar, Jahangir, Sahjahan and Aurangzeb.

The Badshahi Mosque

This beautiful building was erected about the year 1674 for the Emperor Aurangzeb by Fudai Khan Koka

and was a part of the fort and palace. It is the last architectural monument of the Mughal period.

Ranjit Singh's Samadh (Tomb)

It is a curious mixture of Hindu and Muslim notions of a Samadh and a Maqbara. It is situated quite close to the Fort; and there lie the ashes of Maharaja Ranjit Singh, his sons Kharak Singh and Naunihal Singh and some of the *Ranis* who became *Sati*.

Hazuri Bagh

The Hazuri Bagh lies between the Fort and the Badshahi Mosque. This is a well laid out garden. In the centre is an elegant marble pavilion called the Baradari, built by Maharaja Ranjit Singh, who transacted State business here.

Shahdara

The Shahdara gardens owe their existence to the tomb of Jahangir raised by his devoted widow, Nur Jahan. The great emperor expressed a wish, when on his death bed at Rajauri, on the Bhimbar Kashmir road, to be buried in the gardens of Nur Jahan. This mausoleum is a fine specimen of Mughal architecture and is situated on the other side of the river and was built in the year 1606.

Mausoleum of Asaf Khan

This celebrated tomb, now shorn of its sumptuous magnificence, lies to the west of Jahangir's tomb. Asaf Khan was brother of Nur Jahan and the father of Mumtaz Begam of Taj Mahal fame. He was also Jahangir's Minister. The monument was erected about the year 1642. Maharaja Ranjit Singh stripped off the white marble of this beautiful building.

Rauza (Tomb) of Nur Jahan

Nur Jahan designed and supervised the erection of the Rauza. It is now situated close to the tombs of her brother Asaf Khan and her husband Jahangir. Nur Jahan died in the year 1638 at the age of 72 and her remains rest here. Beside her sleeps her only child Ladhi Begam, daughter of Sher Afgan. The Tomb was entirely composed of white marble with delicately coloured floral designs in mosaic. All this wealth of ornamentation was stripped off by Ranjit Singh.

These three Mughal buildings were built in the elegant gardens of the Empress Nur Jahan.

Baradari of Mirza Kamran

The right side of the river was in Mughal times ornamented with beautiful gardens, pleasure houses, and mausolea. The river then flowed through beautiful gardens and elegant buildings for a number of miles; and no other river in the world could boast of greater imperial attention than the Ravi. A little lower down were the extensive gardens of Mirza Kamran, brother of Hamayun, and in the centre of these gardens on the right side of the river there was built a pavilion known as the Baradari. It is still standing on the bank of the river, undermined and dilapidated by the encroachments of the river. This seems to be the oldest specimen of Mughal architecture in Lahore. Mirza Kamran received as his portion the Punjab along with Kabul and Kandahar. Besides the Baradari he built a palace in the middle of a garden on the left side of the river, at a cost of nine lakhs of rupees, from which it received the name of *Naulakha*. No trace of the garden or the palace is left now, but the name survives in the locality near the railway station. Kamaran may be said to have been the father of Mughal architecture in Lahore.

Tomb of Anarkali

This is another specimen of Mughal architecture erected by Jahangir alongside the old river along what is now the Multan Road, in honour of a beautiful girl in the *Harem* of his father Akbar. Anarkali (Pomegranate Blossom) was a pet name of Sharaf un-nisa, otherwise known as Nadira Begam. The central building is used as the Historical Record Room, but the cenotaph at the east end, in pure white marble, is one of the gems of Lahore architecture. When Anarkali died in 1599, this monument, as the resting place for her remains, was erected in 1615. In the neighbourhood of this building are the offices of the Punjab Government, those of the Financial Commissioner, and the Council Chamber for the reformed Legislative Council.

Chauburji

Chauburji, an isolated arched gateway, stands still lower down along the Multan Road, and marks the site of the famous gardens of Zeb-un-nisa Begam, the talented daughter of Aurangzeb. The gardens have all been washed away by Ravi floods, but the gateway with its beautiful glazed tiled-work still stands as a ruin. On the completion of the gardens they were given away

by the princess to Mian Bai, the female superintendent of the gardens, and the fact of gift stands recorded on the main archway. Zeb-un-nisa's tomb is shown lower down the road, in the village of Nawkot, but its authenticity is doubtful.

The City

The walled city of Lahore is a trapezium in shape, with the fort and the Badshahi Mosque on its northern side. It is about a square mile in area and is one of the most congested cities in the world, with narrow lanes and insanitary buildings. The extension of the population east and south is, however, on more modern lines. In the last census Lahore (including cantonments) had a population of 281,781. It is a growing city and in 40 years its populations has increased by about 80 per cent. With the civil station it covers an area of about 30 square miles.

The general aspect of the walled city from without, except on its northern front, is not imposing, nor does it lay any claim to regularity or symmetry. Within the city there are no Hindu architectural remains or historical buildings. There are a few specimens of Pathan buildings, but Mughal architecture is the pride of Lahore. Entering by the Dehli Gate from the east, you come upon the Chauk, and the mosque of Wazir Khan which was built in 1634. He rose to the position of Governor of Lahore. This building presents some of the finest specimens of arabesque designs to be seen in Lahore.

Not far from this mosque there is another mosque, of a much later date, built by Bikhauri Khan in 1753, with gold plated domes, from which it is popularly known as *Sunehri Masjid* or the Golden Mosque.

The City Wall

It was erected by Akbar and surrounded by a moss on three sides and later on improved by Maharaja Ranjit Singh. After the annexation the moss was filled up to make room for the gardens which now encircle the city, and still later the wall was pulled down to allow the access of fresh air to the city.

The city wall was pierced by 13 gates. These still remain, though they were rebuilt after the annexation. Of these the Lohari Gate is the one that opened in the direction of the Hindu city of Lohawar to the south. The Hindu city lies entombed in the mounds of the extensive graveyard known as Miani Sahib and lately (on the 25th February 1926) it yielded two sculptures of great archaeological interest which have been deposited in the Central Museum.

Modern Buildings

The University buildings form a compact group. The Punjab University Union, and University Hall, where convocations are held, are well situated, facing the Mall and flanked by the University Laboratories on one side and the offices of the Director of Public Instruction on the other. Behind this, on a road not quite so presentable, are the University Library and the University Offices with the newly built Hailey Hall, in which the meeting of the Senate are held. The High Court is housed in a building worthy of the dignity of the highest court of the Province. The Government House stands on the side of a Mughal tomb. The Town Hall is situated in pleasant surroundings in the Gol Bagh. The Central Museum close by has a fine collection of coins and of the Gandhara sculpture. The Cathedral is a notable red-brick Gothic building. The latest addition to the beautiful Punjab buildings is the Assembly Building on the Mall, behind the Queen's statue. It is a fine building with stone figures. Besides accommodation for 175 legislators nearly an equal number of visitors could be accomodated there. The whole place is air-conditioned and all modern amenities are available.

Gardens

Besides the Shalimar Gardens and the gardens attached to the tomb of Jahangir across the river, there are three gardens close to centres of population. One is the garden skirting the circular road, which occupies the site of the old moss round the wall of the city, and forms a lung for the city population. Then there is the Gol Bagh, round which are grouped the Town Hall, the Museum, the Mayo School of Art, the University Hall, the University Laboratories, and the Government College, a fine group architecturally, but exhibiting neither unity of style nor design. Finally there are the Lawrence Gardens, covering an area of 157 acres, situated right in the centre of the civil station. In this are situated the Gymkhana Club, the Cosmopolitan Club, and other clubs, as well as the Botanical and Zoological gardens.

The Mall Road

This is one of the most picturesque as well as beautifully kept roads in the whole of India, and Lahore is just proud of it. The Upper Mall is skirted by palm trees, and a well kept footpath on one side and a ride for equestrians on the other. It passes the Aitchison Chiefs' College, the Punjab Club, Government House, and Nedou's Hotel on the right, going towards the city, and Lawrence Gardens on the left. After this are the fashionable shops. Lower down on the left are the handsome High Court Buildings and the General Post Office. Further on we come to the Gol Bagh and the university precincts. Of the sixty-two colleges affiliated to the Punjab University in arts and vocational subjects, seventeen colleges are situated in Lahore. Of these nine colleges are affiliated for degree courses in pure arts and science subjects and eight for vocational studies. These are Govt. College, Forman Christian College, Dyal Singh College, Sanatan Dharm College, D.A.V. College, Islamia College, Sikh National College, Kinniard College and Govt. College for women for pure arts and science subjects; the Maclagen Engineering College, Hailey College of Commerce, Law College, K. E. Medical College, De Montmerancy College of Dentistry, Central Training College, Lady Maclagen Training College for women and Sir Ganga Ram Training College for women for vocational studies. The Punjab Veterinary College and the Mayo School of Arts and Crafts are also situated in Lahore; but these are not affiliated to the University. There is a great demand for higher education for women in Lahore and the two womens' colleges, namely, Kinniard College and Govt. College for Women cannot meet the demand. Three other womens' colleges, namely, Mahila Maha Vidyalaya, Fateh Chand College and Private College for Women, though not affililiated to the University, are catering to the needs of many. For the sons and daughters of the Chiefs we have Aitchison Chiefs' College and the Queen Mary College. These institutions are also not affiliated to the University. The agricultural colleges affiliated to the Punjab University are all situated outside Lahore, namely, at Lyallpur, Amritsar and at Peshawar. Higher science teaching is under the control of the University. It maintains an Honours School of Chemistry, an Honours School in Botany, an Honours School in Zoology, an Honours School in Physics and an Honours School in Technical Chemistry.

Physical instruction forms an important part in primary, secondary and college courses. The University has a Director of Physical Education. Military education is popular. Most of the colleges maintain one or more detachments in the University Training Corps and Military Science is one of the optional subjects for the degree courses. Social life of the students is mainly centered on the colleges. Mention may be made of the Y. M. C. A. Hall and the University Union. There are quite a number of societies in Lahore for propagation of literary and scientific knowledge. In this connection the names of the S.P.S.K., Literary League and the Arts Circle may be mentioned. The Indian Chemical Society and the British Medical Association have their branches in Lahore. There are three important libraries in Lahore, namely, the Punjab University Library, the Punjab Public Library and the Dyal Singh Library. The Irrigation department has its laboratories also in Lahore.

H. C.

Address of Prof. J. C. Ghosh, General President, Indian Science Congress, Lahore, January, 1939

THE Indian Science Congress meets today at Lahore for the third time. Those of us who attended the meeting of the Congress held in 1927 know well that in warmth of welcome and hospitality, and in providing a congenial atmosphere for our deliberations, this city has few equals; and I am sure that on this occasion also, she will live up to that reputation. As President that year, we had Sir Jagadish Chandra Bose, and I well remember the illuminating address in which he outlined some of his beautiful methods for probing the secrets of plant life. That voice is now stilled in death but he will always be remembered with gratitude as the great Master and Pioneer whose work and example have revived the spirit of scientific enquiry in India after centuries of stagnation.

Last year, the Indian Science Congress celebrated its jubilee with great pomp in the city of Calcutta, which had witnessed the birth of this Association, two years after her dethronement from the proud position of the Imperial Capital. A brilliant galaxy of scientists took part in the deliberations, and for President we had elected the greatest scientist of the British Empire. The sudden death of Lord Rutherford was a cruel blow, but it was some consolation that he finished the writing of his inspiring address which was read by his brilliant successor Sir James Jeans.

As I recall today these great names, I feel weighed down by a sense of responsibility. To follow them is perforce to follow very far behind. Eleven years ago, Professor Simonsen was called to this office, and in the course of his address, he suggested that the chemists of India should study more intensively the wealth of natural materials that lay at their doors, and devote less time to the study of problems of only theoretical interest. In the decade that has passed since Professor Simonsen made this eloquent appeal, the organic chemists of India have made many important contributions to our knowledge in this field. Only recently I attended the symposium on this subject held at Bombay under the auspices of the National Institute of Sciences. Distinguished visitors from Lahore, Bangalore and Calcutta joined in the discussion and it looked like a miniature science congress. While not long ago, Professor Simonsen was the solo-scientist in this field, we have now flourishing centres of research at Lahore under the guidance of Dr J. N. Ray and at Bangalore under Dr P. C. Guha. Valuable work is being done in Bengal by Dr P. C. Mitter, Dr P. K. Bose, Dr Khuda and Dr Guha Sarkar, in Bombay by Drs. Wheeler, Shaha, Venkataraman and their colleagues, in Madras by Dr B. B. Dey, at Allahabad by Dr S. Dutta and at Aligarh by Dr. Siddique. Although their interests are mainly pharmacological, Colonel Chopra, and Professor S. Ghosh have carried out systematic chemical examinations of many indigeneous medicinal plants at the School of Tropical Medicine. In very broad outlines, it may be stated that these investigations have embraced the isolation, the determination of the constitution, and in some cases the syntheses, of a large variety of terpenes, bitter, principles, glucosides, plant colouring matters, alkaloids etc. Special mention may be made in this connection of Mitter's elegant synthesis of *Munjisthin*, Ray's work on berberine, palmitine and vasicine, and Guha's synthetic work on thujane, pinane and camphane series.

To a physical chemist, the development of a new technique for the separation of allied substances occurring together in nature has a special appeal. In the Bombay symposium, Prof J. N. Ray demonstrated the existence of six allied colouring matters in rottlerin by their differential *adsorption* on specially prepared surfaces of alumina. Equipments for

fractional distillation under very high vacuum, 10^{-5} or 10^{-6} cm of mercury, are now not rare. In the laboratories of Drs Krishnan, B. B. Ray, K. Banerjee and Mata Prasad, have been installed excellent X'ray equipments for determining the configurations of unit cells in organic crystals. It is hoped that these methods will find increasing applications in the Indian laboratories where many difficult problems are now being tackled by chemists who estimate work by its quality and not by any other standard.

The subjects of vitamins and hormones have now become favourite topics of conversation even in our drawing rooms; and in recent years Nobel Prizes have become practically the monopoly of the great leaders in this field—Hopkins, Neuberg, Wieland, Szent-Gyorgi, Haworth and Peters. It is a matter of satisfaction that synthetic work in India is being directed more and more to the preparation of substances of biological importance. The elegant syntheses by Bardhan and co-workers in the phenanthrene, hydrophenanthrene and retene groups which are closely allied to the sex-hormones have justly received a wide recognition. A class of compounds which now fills the centre of the picture in the chemical world is known as the sterols. Irradiated ergosterol is the vitamin D which is responsible for the formation of bones in animal organisms. It is remarkable that in the economy of nature these sterols should be so closely related on one side to the cancer-producing substances and on the other to the sex-hormones. Vegetable oils and plant juices contain any number of sterols, and I commend to your attention the work on plant sterols that is being done by Drs K. P. Basu and M. C. Nath in Dacca.

Dr B. C. Guha and co-workers have isolated renoflavin from ox-kidney, and have thrown considerable light on the multiple nature of vitamin B_2 of which lacto flavin is one component. It may interest you to know that pure and crystalline lactoflavin is now available in the market at a cost of Rs. 1,000 per gram, and physico-chemical methods have been evolved for estimating it even to a billionth of a gram. Since Szent-Gyorgi's classical investigation on the isolation of vitamin C in a pure crystalline form, the determination of its constitution has formed the subject of brilliant work by Haworth and his school. Work of considerable value has been done in India on the occurrence, stability and physical properties of this vitamin. In the pure state, it is easily oxidised by the oxygen of the air, but it is remarkable that it is very stable in plant and animal organisms, though the tissues receive an ample supply of oxygen. This stability has been traced to the simultaneous presence in these tissues of sulphur compounds or of chlorophyll which act as powerful inhibitors of this auto-oxidation (Ghosh and Rakshit).

In the limited time at my disposal, it is not possible to refer to all the investigations in this field, but I have given you sufficient indication of the striking change that has come over in the outlook of our organic chemists. Professor Simonsen's appeal from this chair has fallen on a rich soil and is now bearing ample fruit.

A few years ago, Sir Gilbert Morgan referred to the question that was often anxiously raised in the British chemical circles as to "what had become of inorganic chemistry" and gave a decidedly assuring reply by his masterly survey of the progress of modern inorganic chemistry. He showed how apart from such sensational discoveries as the hydrogen isotope or Deuterium, inorganic chemistry has now gained freshness of outlook and fertile fields of research by new ideas on valence force. Three kinds of links are now well recognised as binding atoms to form molecules, or binding molecules to form, what we used to call, additive compounds. They are (1) the electrovalent link where the forces are mostly of electrical attraction, (2) the covalent links where the atoms are bound together by sharing two electrons, and (3) the co ordinate links where generally both the shared electrons come from the same atom. The applications of these theories have been amazingly wide. To mention only a few, I may refer to ionic isomerism, isomorphism in crystalline compounds, stability of organometallic compounds, especially when one associating compound occupies two places in the co-ordination complex and the elucidation of the structure of even such a complex molecule as $H_3\,P(W_3\,O_{10})_4\;n.H_2O$, where the chemist's institution has been verified by X'ray analysis.

A similar question "What has become of inorganic chemistry in India?" has often been asked and by no less an eminent person than Sir P. C.

Ray. The dawn of modern chemical researches in India was heralded by his discovery of mercurous nitrite which was followed by many interesting studies on the stability and the properties of the nitrites. The University College of Science at Calcutta has continued to be a very active centre of research in this field. Indeed Sir Gilbert Morgan's review contains appreciative references to the researches of Dr P. B. Sarkar, which revealed the isomorphism of the thiocyanates and acetylacetones of scandium with those of the iron family, and to his interesting study on the homology of beryllofluorides, sulphates, and monofluophosphate ions. This work has been followed by the interesting discovery that a nitrite can form mixed crystals with such an apparently dissimilar ion as the formate. Of the many interesting contributions of Prof P. R Ray, I may mention his preparation of the two isomeric modifications of thiosulphuric acid, whose salts are commonly known as 'Hypo' in commerce.

One of the most remarkable developments in the field of inorganic chemistry has been the discovery of specific reagents for detecting and estimating metallic radicals even when present in such small traces as one millionth of a gram. These newer methods of microchemical analysis bid fair to supersede, in ordinary laboratory practice, the painstaking and disagreeable methods of qualitative and quantitative separation which have hitherto formed the basis of a chemist's practical training.

To the Indian chemists we owe the introduction of many important microchemical reagents *e.g.*, rubeanic acid, urotropine, quinaldinic acid, dimercapto-thiobiazole, and the triple nitrites of the alkali and rare earth metals. These names may appear as Greek to many votaries of other sciences who are present here, but I may assure them, that if these reagents were in common use in their early youth, the goddess of chemistry would not have appeared to them in her frowning forbidding looks, and perhaps many of them would not have hesitated to transfer even their allegiance to her.

But when all is said and done, it cannot be denied that the enthusiasm for research in organic chemistry has overshadowed the claims of inorganic chemistry in India. Isolated work in this field appears often from the laboratories of Lahore, Patna, Bombay and Bangalore, but they do not appear to emanate from flourishing centres of research, where the wisdom and experience of elders combine with the freshness, enthusiasm and devotion of the younger men and create new channels of knowledge. This lop-sided development is indeed to be deplored. They say that all knowledge is one: and with greater truth can it be said now, that there are no longer any barriers between organic and inorganic chemistry. With our newer ideas of valency, the systematisation of the enormous accumulation of chemical facts is no longer the prerogative of organic chemistry. Nor can it be said now that the nature of carbon carbon links is better understood, in spite of its regularity of behaviour, than the links between the other atoms. The elucidation of the structure of inorganic compounds has to be tackled more or less on the same principles which are familiar to the organic chemist. In the common region of the two sciences a vast body of organometallic compounds has emerged, which apart from their interest in microchemical process of analysis, are now working miracles in the fields of industry and in the alleviation of human suffering. I need only mention a few names, lead tetraethyl, neosalvarsan, neostibosan. Our President of the Indore session described last year how kala-azar had been practically eliminated from the otherwise smiling fields of Assam and Eastern Bengal, with the aid of the drug ureastibamine. Antimony III pyrocatechine disulphonate of sodium has brought under control bilharziasis in Egypt, and is now named Fouaden after the King of Egypt, who took a great interest in this work. With inorganic chemistry revitalised by the electron concepts of valence, there is a rich harvest to be garnered in the near future by our brilliant young chemists, if only they could resist the lure of pure organic chemistry.

A sketch in bold lines of the progress of physical chemistry in India may not be out of place here, if only to complete the picture that was drawn by Professor Bhatnagar as the President of the Chemistry section of our congress in 1928. It was only after the war that this branch of chemistry came really to be cultivated in the Indian laboratories. Progress here depends no doubt, as in other branches of knowledge on inspiring leadership; but the proper equipment of laboratories is also an equally vital factor for success. In many centres, this youthful science has suffered from a chronic anaemia for lack of funds available for

research; and the cry has sometimes been raised in authoritative circles, that in consideration of this lack of resources, physical chemistry should better be merged into physics. It is also extremely unfortunate that the professorship of physical chemistry in the Indian Institute of Science at Bangalore should have been kept in abeyance, and the department practically wiped off the scene. Now that the Irvine Committee has strongly deprecated this measure of retrenchment, it is to be hoped that the department of physical chemistry should occupy at an early date a worthy place in that Institute, which was intended to be the premier centre for chemical researches in India.

The credit of initiating researches in physical chemistry in India goes to Professor Dhar who was called to the chair of chemistry at Allahabad in 1919. Then came in 1921, the three musketeers from the laboratory of Professor F. G. Donnan, Bhatnagar, Mukherjee and Ghosh; and later on the torch has been kept burning by Qureshi at Osmania, Joshi at Benares, Mata Prasad at Bombay, Ganguli and Ray at Patna, Krishnamurty and Kappanna at Nagpur, Ramkrishna Rao and Gopal Rao at Waltair, and Sanjib Rao and Jatkar at Bangalore.

During recent years Dhar and his pupils have applied the methods of physical chemistry to the elucidation of various chemical processes that occur in soils and have come to the conclusion that tropical sunlight is one of the governing factors in these transformations. Such powerful radiations easily decompose potassium nitrate, bring about reaction between sulphurous acid and oxygen, give rise to formaldehyde in solutions of alkaline bicarbonate, and in presence of catalytic surfaces like zinc oxide, and titanium oxide, even produce amino acids by reaction of glucose with potassium nitrate. They have observed that amino acids are readily oxidised to ammonia in air and light, and ammonium salts in their turn are oxidised to nitrites and nitrates. These observations coupled with the fact that the amount of nitrate in the soils of northern India is maximum in summer when bacterial activity is practically negligible, lead to the very important conclusion that tropical light plays an important role in the nitrification of soils. The parallel investigations of Fowler, Subramanyan and their collaborators on the fixation of nitrogen in energy-rich soil with the aid of micro-organisms, of Dr P. K. De on nitrogen fixation by algae and of Dhar on the fixation of nitrogen by catalytic surfaces during the photo-oxidation of organic residues are throwing a flood of light on the economy of carbon and nitrogen in the soil system. This is, as it should be, the fundemental problem of Indian agricultural for the conservation of nitrogen and moisture in the soil. It is a matter for sincere congratulation that these researches on soil processes will be continued with greater chances of success, because of the singleness of purpose and devotion, in the Indian Institute of Soil Science which has been recently established at Allahabad by Professor Dhar.

While Professor Dhar's interest has centred round the physicochemical processes that occur in soils, Professor Mukherjee has of late concentrated his attention on the colloid chemical behaviour of the soil constituents. He has applied with success his well-known theory of the electrical adsorption of ions to the elucidation of the properties of clay-acids and soil suspensions. The accurate experimental technique which he has evolved, in this connection, for the determination of cataphoretic speed, and for conductometric and electrometric titration of acid sols are well worthy of imitation in all soil science and electrochemical laboratories. The colloid constituents of the soil are responsible for many of its most important physical properties, its power of holding water, of forming crumbs and tilth and for its general relation to plant growth. Professor Mukherjee has gone into the root of the problem. He has made comparative studies of the changes that happen when alkali is gradually added to (1) simple sparingly soluble acids in (a) presence or (b) absence of solid phase (2) to colloidal acids like palmitic and silicic acids and finally (3) to the more complex clay acids. His programme of work may well serve as a model when a complex piece of very difficult research is planned; results of far-reaching value have thus been obtained which have received wide recognition in Europe. It is also worthy of note that researches on the colloidal behaviour of drilling mud has just been started by the Assam Oil Company under the supervision of Professor Mukherjee at Calcutta. The problem of reversible transformations of suspensions into jelly like masses and *vice-versa* is also of great technical interest. The studies of Professor Mata Prasad on the mechanism of the formation of many inorganic and

organic gels thus deserve special mention. By the proper control of H' ion concentration, he has prepared, for the first time, many beautiful transparent gels whose properties are being exhaustively studied by him. An important application of the methods of colloid chemical separation to a problem of great therapeutic interest has been made by Dr B. N. Ghosh who is investigating the physico chemical properties of snake venom. The possibility of separating completely the neuro toxin from the haemolysin factor in the snake venom appears to be at a promising stage of development.

Apart from his ever-increasing activities as a pioneer industrial chemist, to which reference will be made later, Professor Bhatnagar has carried on a systematic investigation on magneto chemistry and molecular structure. Perhaps the most sensitive instrument that has yet been designed for the study of magnetic susceptibility is the Bhatnagar Mathur interferometer balance, which has now been put in the market by Adam Hilger Ltd. I wish it were possible to discuss in detail and in a non-technical manner, the more important contributions of Bhatnagar, D. M. Bose and P. R. Ray and Krishnan to the rapidly developing field of magneto chemistry. It is well known that in a non-uniform field, paramagnetic substances experience a tractive force towards the strongest part of the field, while diamagnetic substances experience a similar force to the weakest part. Bhatnagar has shown that such magnetic behaviour is not an unchanging property of atoms or ions. The remarkable fact has been noted that paramagnetic substances like iron, nickel and cobalt, exhibit diamagnetism when adsorbed by charcoal, which indicates that chemical valence forces are in operation in the process of adsorption. The magnetic susceptibilities of organic isomeric molecules are not the same, but depend on the arrangement of the atoms in the molecule. Again the study of chemical reaction in a magnetic field has led to the important generalisation that the velocity of reaction is accelerated, retarted or unaffected by the field according as the sum of the molecular susceptibilities of the final products is greater, less or equal to the sum of the molecular susceptibilities of the initial substances.

Important researches are in progress at Benares on the mechanism of chemical reactions under electric discharge. It has been found that many chemical reactions will occur only if the voltage across the reaction space exceeds a limiting value which has been aptly termed the threshold potential. Traces of impurities which act as catalytic poisons also increase considerably this threshold potential. Velocities of reaction were also found to be markedly depressed in presence of molecules which have large affinities for electrons.

While the laboratories at Lahore and Benares are engaged in the study of properties of molecules in magnetic and electric fields, physicochemical researches in Dacca have been concerned with an intensive study of the interplay of matter and radiation, mostly in liquid systems. The nature of such interaction when atoms and molecules are in the gaseous state is now fairly well understood, but in liquids the phenomenon is much more complicated. Our interest ceases when the light absorbed is simply converted into heat. But radiant energy, of a particular wave-length, may in some cases be absorbed by a molecule, which immediately emits a band of secondary radiation. This is the so-called fluorescent band. For a true understanding of the mechanism of the process it is necessary to measure accurately the distribution of energy over the various wave-lengths of such a band and also to compare the amount of radiant energy absorbed by a molecule with the amount that it emits as fluorescence. This ratio is called the fluorescent yield. Absolute photometric methods of extreme sensitiveness have been devised, and some of the results obtained may here be stated. As the concentration of fluorescent molecules in an inert solvent like water or alcohol diminishes, the fluorescent yield increases until a maximum steady value is reached at molecular concentrations of the order of 10^{-4} or 10^{-5}. Electro-chemical studies indicate that at these low concentrations, the fluorescent molecules only exist as simple ions whereas at higher concentrations ionic aggregates or micelles are formed. The decrease in fluorescent efficiency is associated with an increase in the complexity of ions. Even under the most favourable conditions, this efficiency never reaches unity. Molecules like rhodamine and fluorescien are good energy transformers, the yield reaching up to .8, while low down in the list we have phosphine G with an yield of .1 of the absorbed energy. A molecule of rhodamine again may absorb a quantum of radiation corresponding to wave-lengths 313, 365, 436, 546, 10^{-7} . .

But in each case, the nature of the fluorescent band and the amount of fluorescent energy per quantum of absorbed radiation remain the same, though the absolute magnitude of the exciting quanta thus varies over a wide range. It is possible to go deeper into the problem. For example in the delicate experiments of Mr S. Mitra, a beam of light with vibrations arranged in one plane only, was made to strike such a molecular target in a viscous medium, and the fluorescent light measured along a direction normal to the plane containing the direction of vibration and the direction of propagation of incident light. It was found that in the fluorescent light the vibration along the direction of propagation is generally less intense than the vibration in the perpendicular direction. This anisotropy, or polarisation as it is called, diminishes as the viscosity of the medium diminishes. This is to be expected for if within the life period of the excited molecule, which is of the order of 10^{-10} second, the fluorescent molecule is capable of considerable free rotation in all possible directions, no particular direction of vibration will be favoured in the emitted light. Based on this elegant method, the life period of excited molecules has been measured.

The emission of fluorescent light is a relatively simple response called forth in a molecule under the stimulus of radiation. A more complex process occurs when the radiation is stored up as the internal energy of molecules. The green plants bottle up sunshine to the extent of 670,000 calories when they transform six gram molecules of carbon dioxide and water into one more of sugar. These are the fundamental capitalists of the world on whom all the animals have to depend for their existence. A molecule with such an accumulated store of energy may occasionally remain fairly stable as in the case of sugars. But in other cases instability and far-reaching changes are noticed; for example with bromine the molecule splits up into two atoms; in the case of iodine, either the molecule is split up or an excited molecule is formed. These free atoms and excited molecules are very active agents and they start all kinds of reactions when other receptive molecules are present. Where the induced chemical reaction is attended with evolution of heat, each such atom or molecule acts, as it were, as a centre of explosion, which proceeds in a chain involving sometimes the transformation of hundreds of molecules. The conditions which are favourable for the propagation of such chains, the dependence of the chain length on the magnitude of the quantum of radiation responsible for starting the chain, the disruption of the chain by substances which we call catalytic poisons, the life period of excited atoms and molecules, and of the unstable substances that are formed as intermediate products in such reactions,—these are some of the problems which have been studied in Dacca

It is possible with the aid of suitable devices to obtain a beam of light in which the vibrations are circular and either dextro-rotatory *i.e.*, moving in the direction of the hand of the clock, or laevo rotatory *i.e.*, moving in a contrary sense. Such radiations, may be called, in short dextro-light or laevo-light. If dextro light has a different velocity than laevo-light in a medium, the medium is said to be optically active. Again if the absorption coefficient of dextro light is different from that of laevo-light, the medium is said to be circularly dichroic. Such optical activity and circular dichroism are often exhibited by naturally occurring molecules; and the prevalence of such asymmetry in living organism has been considered as a proof in favour of vitalism. The brilliant researches of Kuhn in 1930 indicated how with the aid of one kind of circular light, an asymmetric molecule can be decomposed in preference to its optical isomer which is always present in equal amount in all synthetically produced substances. The plant pigments which under the stimulus of solar radiation are responsible for the production of complex organic materials, exist in living cells as colloidal micelles, which are both optically active and circularly dichroic. Attempts to prepare relatively simple colloidal micelles exhibiting circular dichroism have been quite successful in our laboratories. When colloidal solutions of tungstic acid, vanadic acid, or ceric borate are allowed to mature in dextro light which they are capable of absorbing, the molecules during the process of aggregation to form micelles appear to be subjected to the directive influence of such radiations. Such colloidal solutions have greater absorption for dextro-light than for laevo-light *i.e.*, they become circularly dichroic. Experiments now in progress also lead to the conclusion, that these dichroic suspensions, which become active oxidising agents under the influence of light, exhibit differences in the velocities of oxidation, when exposed to equal intensities of

oppositely polarised circular vibrations. It looks now, as if it may be possible to prepare in the laboratory, simple anisotropic catalysts which will produce much faster one optically active substance in preference to its isomer.

I should not let this occasion pass without dwelling on a matter of vital importance relating to the training of a physical chemist. Half a century ago, this science was brought into being by the labours of Van't Hoff, Arrhenius, Ostwald, and Raoult. Even the mathematical equipment of Van't Hoff, the greatest of these leaders, was according to Sir James Walker, no better than that of an ordinary graduate in mathematics. An easy familiarity with relatively simple mathematical tools coupled with a clear grasp of the fundamental laws of physics, has since enabled many to collect a rich harvest from the virgin soil. But things are now changing fast. The appointment of Dr Lenard Jones to the chair of inorganic and physical chemistry in Cambridge is a symbolic event. Of a physical chemist is now demanded not only a sound basic training in chemistry, supplemented by a high experimental skill in handling delicate instruments but also a clear understanding of the higher branches of applied mathematics and statistics. How we wish that we were trained up on this basis; but let not those who come after us, have occasion to complain that they did not receive proper guidance and counsel in the years of their apprenticeship. And I appeal to the Indian universities to take up seriously the question of a thorough overhauling of the methods of teaching of this branch of knowledge.

I must confess that the section of physics and mathematics has to its credit more far-reaching discoveries than the section of chemistry. I need only mention the Raman Effect, the Saha Theory of Stellar Ionisation and the Bose Statistics. I should like to stress here one great obstacle to progress which the chemists of India have not yet been able to remove. Chemists are apt to describe themselves as the most painstaking of all animals, not even the ass expected. It is more true of their science than that of any other, that innumerable experiments must be performed, innumerable facts observed, catalogued, correlated and classified before an important generalisation can be made or the structure of a new conception of the phenomenal world can be raised. But life is short and science is long. Hence it is, that we find that outstanding discoveries in chemistry have in recent years been made in laboratories, where inspiring leadership has been associated with large-scale team work. The paper on the synthesis and constitution of vitamin C appeared from the Birmingham laboratories under the joint authorship of a team of seven workers. Such team work is however yet comparatively unknown in India. It is to be deplored that the idea of close co-operation among the scientific workers, has not taken a firm root in the Indian soil. Is it due to the fact, that the traditional religious atmosphere of India teaches a child to be self centred, to be complete within himself and to work out his own salvation, unaided and in isolation? Then again, I am told, that a tradition has grown in some institutions, that the senior member of the staff is given credit for senior authorship in a joint publication, independent of any consideration of the share he may have in the planning and execution of the work. This, if true, is unfortunate, for the highest spirit of co-operation, loyalty and devotion can only be evoked in an atmosphere of impartial justice and deepest sympathy and good will. Notwithstanding these handicaps, there are pointers to the road of success. In the palmy days when Sir C. V. Raman was professor in Calcutta, one could easily feel that in his laboratory, the researcher has become forgetful of self and mindful only of the work ahead. One also notes with pleasure the observation of Sir John Russel that Professor Mukherjee is fortunate in having secured the help of a band of skilled and devoted workers in his researches on soil colloids. Any casual reader of Indian publications in chemistry will not fail to see that work of considerable value has been done during the last decade. He will observe however, that it is the individual enterprise in research, rather than a magnificient team work to solve a fundamental problem, which has been up till now, the keynote of our activities. But for greater efforts and higher achievements we should all endeavour to inaugurate an era of co-operative team work.

Within the precincts of this university ,it is not necessary that I should have to make a special pleading for theses that scientific knowledge and industrial activities should be co-ordinated or that our academic laboratories should not be divorced from practical affairs. We have here a flourishing honours school of technical chemistry; and the

genius of Professor Bhatnagar has provided a bridge of communication between scientists and industrialists. Nowhere is the benificial effects of contact between universities and industry better exemplified than in the programme of researches on oil technology, now carried out under the supervision of Professor Bhatnagar, with the aid of funds provided by Messrs Steel Brothers. In pre-War days, such close intimacy existed in Germany alone with the result that she rapidly outstripped her rivals in industrial enterprises. But a new epoch of industrial research in Europe and America has begun with the end of the Great War. Last year in the presidential address of Lord Rutherford we had a very clear exposition of the extensive activities of the Department of Scientific and Industrial Research in Great Britain. He stated with evident satisfaction that this bold experiment in this co-operative organization of research, which is unique in the world, had undoubtedly proved a great success.

The Government of India have, in recent years, done a good deal in promoting researches relating to plant industries. The Royal Commission on Agriculture has ardently looked forward to a state of affairs in which the universities will not only initiate agricultural research but will also undertake schemes of research, the importance of which is brought to their notice by the departments of agriculture. This end has been steadily kept in view by the Imperial Council of Agricultural Research. We have already referred to the researches of Professors Dhar and Mukherjee. With the aid of funds provided by this council, long-range schemes of research are in progress in the statistical laboratory of Professor Mahalanobis at Calcutta, in the chemical laboratories at Dacca, and in the botanical laboratories of Agra, Madras and Benares. The Cotton Technological Laboratory at Bombay, the Institute of Cotton Breeding at Indore, the Imperial Institute of Sugar Technology at Cawnpore, the Cane Breeding Station at Coimbatore, the Jute Technological Laboratory at Calcutta and the Agricultural Research Laboratory for jute at Dacca are notable examples of the solicitude of the Central Government for meeting the research requirements of valuable money crops. Researches on forest products have been organised in the Forest Research Institute at Dehra Dun and the Lac Research Institute at Ranchi. The work that is being done in these institutions has gone far to refute the allegation that Indian chemists are doing little to help industry. Take for instance the lac industry. Researches are in progress under Dr Sen, relating (a) to better methods of washing stick-lac to produce high grade seed-lac, (b) separation of pure lac resin from ordinary shellac, (c) bleaching of lac, (d) recovery of refuse lac, and (e) production of moulded articles for electrical industry and household use. The synthetic resins, like bakelite, having entered the field, it is certain that severe competition is ahead. But now that science has been linked to this industry, we may hope with greater confidence, that the lac industry of Chotanagpur will not meet with the same fate as the indigo cultivation of Behar.

At Dehra Dun the ascu process of Mr Kamesam which fixes arsenic and copper in wood through the agency of chromium salts has given rise to a wood preservation industry. The researches of Dr S. Krishna on Ephedra have helped Baluchistan in organising the trade in this drug. Of particular interest is the work that is now being done there on vegetable tallows. The physical and chemical properties of mowra tallow and sal butter have been studied, and they are recommended as admirably suited for yarn sizing. It is estimated that about 400,000 maunds of these tallows can be put in the market; and owing to their cheaper cost of production, they are expected to displace animal tallows for various industrial purposes. Nor should we forget to mention that researches conducted on proper utilization of such forest products as bamboo and grass, have resulted in the establishment of several paper factories; and the time is not far off when the country will be producing enough pulp from these raw materials to meet the overgrowing demand for paper. Dr Chowdhury and co workers at Dacca have made extensive studies on the properties of the jute fibre. They have found that colour can be improved considerably by the action of chlorine peroxide, the tensile strength and resistance against rot by the action of formaldehyde, that jute nitrocellulose can be made as stable as cotton nitrocellulose, and that owing to its lower viscosity and high solubility, it would be more useful for the lacquer industry. It has been found that the jute plant does not rot in tanks of galvanised iron; and Dr Barkar, in his recent review of jute industry in India, has drawn pointed attention

to this observation, as indicating the possibility of controlled retting in central stations for the production of high grade fibres.

I have dwelt in some detail on these researches on money crops which have received generous assistance from public funds, in accordance with the recommendation of the Agricultural Commission, with a view to bringing out in bolder relief the cold indifference, with which the recommendations of the Indian Industrial Commission have been received by the Central Government. Much was expected of the policy laid down by the Government of India in 1915, under the stress of the War, that India would consider herself entitled to demand the utmost help which her Government could afford to enable her to take her proper place in the world as a manufacturing country. But these lessons of War were soon forgotten, and all that has been achieved is the setting up of an Industrial Research Bureau, controlling with the aid of an Advisory Committee, a small research laboratory attached to the Test House at Alipore. The report of this Bureau for 1937-38 is a miserable document compared with the corresponding report of the Imperial Council of Agricultural Research. I should not be misunderstood. I have no complaint against the personnel, but only against the step motherly treatment meted out to industrial research in the country.

Nor should we forget that many great leaders of public opinion have been so impressed by the evils of the modern capitalistic world that they have not hesitated to declare that the introduction into India of the scientific and technical methods of the west should be resisted; that it is no business of governments to subsidise higher scientific research and that those who employ scientific men or exploit their researches should pay for their training and provide them with facilities for work. The forces of public opinion and of Government rarely join hands in this country, but men of science found to their dismay, that this miracle was going to happen in this instance. It was feared that human society in India would in the end crystalise into a community of artisans and peasants. It is therefore with great relief and thanksgiving that we welcome the resolution passed at the conference of the provincial Ministers of Industries recently held at Delhi that the problems of poverty and unemployment, of national defence and economic regeneration in general, cannot be solved without industrialization; and as a step to such industrialization, a national planning commission should be set up which will formulate comprehensive schemes for the development of industries in India.

As an indispensable adjunct to this planning commission there should be set up an All-India Council of Scientific and Industrial Research with functions and powers similar to those entrusted to the Department of Scientific and Industrial Research in Great Britain. In India however, men and things get, so easily and without questioning, under official control that it would be apt to quote here the following observations of Lord Rutherford:—"In Great Britain the responsibility for planning the programme of research even when the cost is directly borne by the Government rests with research councils and committees who are not themselves State servants, but distinguished representatives of pure science and industry. It is to be hoped that if any comparable organization were set up in India, there will be a proper representation of scientific men from the universities and also of the industries concerned."

Indeed for any one who has followed the recent happenings in this world, with any attention, this industrial planning for India would seem to be long over due. Now, more than ever, a planning on all fronts, would seem an urgent and immediate necessity. The lesson of the crumbling empires, and the rapid rise of countries organised in deadly earnest are potent to all but the oblivious utopian. If an industrial and progressive India appeared a desirable necessity in 1915, how much more urgent and imperative would such a task of consolidation of her intellectual and material resources appear to all in 1938. But we, orientals, often forget realities, in our search for the ideal; with the furious tempo of development and consolidation all round, the least delay, however, in this urgent task may prove fatal and irreparable in the end. Already we are regrettably late in putting forth our best efforts in this directions, but now that events have rudely awakened us to the dangers that our slackness exposes us to, we should try to make up for lost time by forced marches in the path of progress, and by a resolute determination to pull all our material and intellectual resources to solve our own problems. It is obvious that such a tremendous task cannot be

achieved by isolated efforts of industrialists, and by private enterprise. The utmost co-operation of the individual with the State will be necessary if real success is to be achieved.

The magnitude of task need not make us despair. The very creditable performances of her sons in the different spheres of scientific and intellectual activity have amply demonstrated that with proper guidance and plan, India is quite capable of solving her own problems, and of maintaining her position and ideal with dignity and prestige. What is only wanted is prudence and foresight, liberal statesmanship, resolute co-operation and efficient leadership.

The universities of India have a great responsibility to discharge at this juncture. If the process of industrialization is going to be a forced march in this country it will not do for them to take up an attitude of *laissez-fair*. The forces of nature are the enduring wealth of mankind, but for the solution of Indian economic problems and the prosperity of her 380 millions, it is necessary that brilliant young men should be trained up in ever-increasing numbers, who are capable of tapping these sources of wealth. The modern young student of science must realise that while fundamental theoretical work must continue to be the basis of all scientific advance, his subject would lose much of its importance, if this training did not fit him for tackling large-scale problems which arise in industries. Simultaneously with the development of industries, there arises in every country a great demand for well-trained personnel to man these industries. Prof. Philips recently estimated that 12,000 graduates in chemistry are employed in industrial pursuits in England. Lord Rutherford even complained that the demand in England for well trained researchers in physics had outran the supply. Dr Hamor, Assistant Director of the Mellon Institute for Industrial Research has estimated that in 1937, America spent about 100 million dollars in scientific and industrial research; and though the expenditure is high, the results have more than fulfilled expectations, even if for a time, some of them may be kept secret. Such a consumation may be long in coming to India, but every effort should be made to prepare the ground in advance. A very good example of what the Indian universities can do in this direction has been shown by Bombay, where under the inspiring leadership of Mr Chandravarkar and the able guidance of Dr Foster, an institute of textile chemistry and chemical engineering has been established, which in equipment has few equals Already successful students have so proved their worth, that I am told, that there is an advance booking from the millowners for the products of this institution.

It is a welcome sign of the times that the Indian industrialists are not all blind to the value of research as a means of improving production, and in consequence, of increasing the demand. The Tata Iron and Steel Works have led the way by the foundation of a magnificent laboratory at Jamshedpur for the study of alloys of iron and steel. The Lala Shri Ram Trust contemplates establishing soon at Delhi an Institute on the model of the Mellon Institute of America. The Luxminarayan Bequest at Nagpur may soon begin to yield the beneficial results which the donor so ardently cherished. But when one recalls that most of the industries in India are now sheltered by a tariff wall—call it revenue tariff or protective tariff as you like—and that a substantial part of the income of the Indian business magnates accrues to them because of this tariff, one has a right to expect a much wider recognition on their part of the need for co operation between science and industry, and a greater readiness to endow industrial research with a view to cheapening production. Such research is considered, in all enlightened countries, as an insurance against the dark days; and today when the world seems so much out of joint, the enlightened industrialists should do well to consider themselves only as servants of society—essentially moral beings whose main dividends are the benefits, which they confer by providing employment, and by manufacturing commodities essential for the national well-being.

But the world will be set right if this change in outlook were confined to one class of men only. Every intelligent man and woman have now got to ponder deeply over the problem that the scientific search for truth has not assured the advance of civilization. Inventions intended to relieve toil, and to control the forces of nature which should have given, to all a fuller and more satisfying life, have been perverted into forging instruments of destruction. The paradox of poverty amidst plenty mocks us in face. In one part of the world wheat and cotton are being burnt and milk thrown into streams, while

in another part half-naked people are starving. It is not difficult to get at the root of this evil. In respect of scientific knowledge and their applications to the problems of life, each generation stands on the shoulders of the preceding one, but in respect of social, cultural and spiritual qualities, no comparable development is noticeable-- perhaps there has been a retrogression since the days of Asoka and Christ. Modern science has, indeed, become a menace to civilization, because we have refused to work for social justice, because the interests of individuals and communities have not been subordinated to those of the country, and because considerations of patriotism and the prejudices of race, creed, and colour, have been allowed to override the wider considerations of humanity. There in lies the tragedy of the modern world the tragedy that we witness in the flaming cities of Spain and China, in the mountain homes of Abyssinia and in the concentrated hatred in the armed camps of Europe.

"It is not enough that mankind should be provided with tools of progress. It is a much bigger task to teach them how to use these tools. Men of science cannot escape moral responsibility even for the evil fruits of their labours." The chaos of modern world is calling out to every man of good will and understanding to join in a great educative effort with a view to making the minds of men more flexible and adaptable, with a view to removing those narrow prejudices which are choking the paths of progress. These prejudices did not matter much in olden days, when communications were difficult --in fact they were born because of such inaccessibility. But today when increasing rapidity of communications is causing the world to shrink with a disconcerting rapidity, these prejudices spell disaster for mankind. We, on this occasion, there fore welcome the efforts of the British Association and the American Association for the Advancement of Science to mobilise the moral forces of the world for promoting better relations between men and nations, and we offer them our willing co operation.

In this hall, many years ago, the first President of the Indian Science Congress, Sir Asutosh Mookerjee concluded an inspiring address with the hymn

"Where knowledge is free
Where words come out from the depths of truth,
Where the clear stream of season has not lost its way into the dreary desert-sand of dead habit,
Unto that Heaven of Freedom, my Father, let my country awake"

Search for such a Heaven of Truth and Freedom-self-surrender to such a great quest it is to this, that the noblest spirits are called; and it is such men and women who make the world a better place to live in. May we all join in this quest!

Short Life-Sketches of the General and Sectional Presidents

PROF. J. C. GHOSH

General President

Born on the 14th September, 1894, in the District of Hooghli, Prof. J. C. Ghosh had his early education at Giridih and then at Presidency College, Calcutta, where he had a uniformly brilliant career. He took his M.Sc. degree in 1915. It was in the Presidency College that he came in contact with Sir P. C. Roy, the father of Chemical Research in India, and derived inspiration from him. When the new Post-graduate Department of the Calcutta University was opened by the late Sir Ashutosh Mookherjee, Ghosh was appointed a lecturer in Chemistry. From here he published his papers on the abnormality of strong electrolytes which attracted attention from scientists throughout the world and which Debye and Hückel took up later on. The award of Palit Scholarship and Premchand Roychand Studentship in 1918 enabled Dr Ghosh to proceed to England. He worked in the laboratory of Prof. Donnan in London for some time and in 1921 he went to Germany. On his return to India the same year he was appointed to the Chair of Chemistry of the newly established University of Dacca, where during the last 18 years he has built up a very active school of chemical research which is doing very valuable work under his inspiring guidance.

Prof. Gosh and his collaborators have carried out intensive and important work in Photo-chemistry. Recently they observed that under certain circumstances an isotropic structure may be produced in a-microscopic sol particles of tungstic acid, vanadic acid, chromic tungstate and ceric borate sols if, during the coalition of molecules to form the sol particles, the molecules are exposed to circularly polarised light. It has also been observed that the velocity of a photochemical reaction with one of the above sols as photosensitizer depends on the nature of the circularly polarised light used for maturing the sol and subsequent irradiation of the re-action mixture. Sols matured in dextro light gave different velocities of reaction for the same intensities of dextro or laevo light used for irradiation and thus bringing about a photochemical transformation. Similar results have also been obtained with sols matured in laevo light.

His work on photovoltaic cells and his quantitative measurement of fluorescent yield have thrown a flood of light on these obscure phenomena, and have been acclaimed as very important contributions to our knowledge of these subjects.

Prof. Ghosh and his collaborators have also carried out important investigations in the domain of technical gas reactions and of oxidation-reduction potential of biologically important substances. He is in receipt of a substantial grant from the Imperial Council of Agricultural Research for carrying out investigations on the mechanical analysis of laterite soils and on the fixation of nitrogen by the rice plant and very interesting and available results have already been obtained by Dr A. T. Sen, and Messrs P. K. De and J. N. Chakravarty working in his laboratory.

Along with Professors J. N. Mukherjee and S. S. Bhatnagar he was responsible for the foundation of the Indian Chemical Society in 1924 and is at present the President of the Society. He also presided over the Chemistry Section of the Benares Session of the Indian Science Congress in 1925.

DR K. R. RAMANATHAN

President, Physics and Mathematics Section

Born in 1893 at Palghat in the Malabar District in South India, Dr Ramanathan graduated with a B.A. (Hons.) degree in Physics in 1914 from the Presidency College, Madras and worked as a demonstrator in Physics in the Maharajah's College, Trivandrum, till the end of 1921. During part of this period, he was also

Honorary Director of the Trivandrum Observatory, and wrote a paper on "Thunderstorms in Trivandrum". Towards the end of 1921, he was awarded a Research Scholarship by the University of Madras and went to Calcutta to work under Professor Sir C. V. Raman. Here he worked on the subject of molecular scattering of light and wrote a number of papers, both theoretical and experimental, on the basis of which he was awarded the degree of Doctor of Science by the Madras University in 1923. His main contributions to the subject of molecular scattering are that he

(1) Established the continuity of the phenomenon of molecular scattering from the liquid to the vapour state through the stage of critical opalescence.

(2) Worked out a molecular theory of scattering in fluids composed of optically anisotropic molecules.

(3) Extended Prof. Raman's studies on the colour of the sea and found evidence that some radiation with changed wave-length accompanied scattering from the clearest sea-water. Showed that the same phenomenon was observable with the purest distilled water, alcohol and some other liquids.

(4) Worked out a theory of optical anisotropy of molecules based on the idea of the mutual influence of the individual atoms composing the molecule.

In 1925, he joined the India Meteorological Department as a Meteorologist. His main scientific work in the Department has been the investigation of the upper atmosphere. His diagram of the distribution of temperature over the earth up to 25 km. based on a study of upper air data over the earth, particularly of those over India, has been taken as standard in all later discussions of the general circulation of the atmosphere. He is the author of many memoirs and scientific notes on meteorological subjects dealing with conditions in the upper air both in normal and in disturbed weather, problems of atmospheric radiation, vertical currents in the atmosphere caused by thermal turbulence, etc. Dr Ramanathan has also studied with his students the light from the night sky over our regions and showed the daily presence of the green and red lines of oxygen and the absence of the nitrogen positive bands in these low latitudes and shown that the daily variation of the light from the sky is different in low latitudes from that over temperate latitudes. During the last two and half years he has been in charge of the Geophysical Observatory of Bombay and got himself interested in problems of seismology and terrestrial magnetism.

At present he is a Superintending Meteorologist at Poona, Foundation Fellow of the National Institute of Sciences, India, and Indian Academy of Sciences, Bangalore, Member of the International Meteorological Commissions for the Upper Atmosphere and for Radiation.

DR P. B. SARKAR

President, Chemistry Section

Born on Nov. 22, 1895, Dr P. B. Sarkar passed the M.Sc., examination in 1916, and was appointed Lecturer in Chemistry of the University of Calcutta in the same year. In 1923, he was appointed Assistant Palit Professor of Chemistry and was awarded Sir Rashbehary Ghosh Travelling Fellowship for the year 1925, which was renewed next year. During these years, he worked on the chemistry of Scandium and the Rare Earths in the laboratory of Prof. G. Urbain, a noted authority on the subject, and obtained a first class Doctorate of the University of Paris (Dr.'es Sc.) in 1927. Since then, he has been carrying on researches on rare earths and along various other lines, and has assisted many of his pupils to work up independent papers of which the chemical analogy between fluoberyllates and sulphates may be mentioned. He is a member of the Chemical Society of France, of the Council of Indian Chemical Society, life member of the Indian Association for the Cultivation of Science, fellow of the National Institute of Sciences, India, Associate of the Institute of Chemistry of Great Britain and Ireland, etc.

PROF. C. R. NARAYAN RAO

President, Zoology Section

Born of a respectable family at Coimbatore, Prof. Narayan Rao had his early education at Bellary under

the late Mr J. P. Cotelingam and entered the Madras Christian College for his University education. He came under the influence of Dr Henderson and had a distinguished record in the University. When the Government of Mysore contemplated the development of Science Departments in the Central College Mr H. J. Bhabha wrote to Dr Henderson to recommend to him an energetic young man to undertake the responsibility of organising the Biology department in the College. Dr Henderson's choice fell upon Rao and his confidence in the ability of his nominee is amply justified by the present position and status of the Department of Zoology, both as a centre of research and of teaching.

Professor Narayan Rao entered the University service in 1909 as an Assistant Professor of Biology and directed the studies in Zoology and Botany till the bifurcation of the Biology department into Zoology and Botany sections, the latter coming under the direction of Dr M. A. Sampathkumaran. With the inauguration of the University of Mysore in 1917, Rao was raised to the Chair of Zoology which he has filled with marked dignity and conspicuous ability all through his service of 28 years' except for a short of a year and a half when he was away at Mysore as Principal of the Teachers' Training College. In 1930 he was appointed as the University Professor of Zoology. He officiated for sometime as Principal of the Central College. He has since retired. He is the Secretary of the Indian Academy of Sciences,' Bangalore and Editor of the '*Current Science*.'

DR D. N. MAJUMDAR

President, Anthropology Section

Dr D. N. Majumdar received his education at the Dacca Collegiate School and the Dacca College from where he graduated in 1921. He joined the University College at Calcutta in 1921 and passed the M.A. examination in 1933 with first class Honours in Anthropology, standing first in order of merit. In 1924, he went to Chotanagpur in Bihar, to study first-hand the social and economic life of the Austric speaking tribes. In 1925, he was awarded the Premchand Roychand Scholarship and the Mount Gold Medal and in 1926 was appointed to the staff of the Lucknow University. He proceeded to Cambridge for further studies in 1932. But in 1934, the Faculty Board of Archaeology and Anthropology sent him out to India to study the effects of culture contacts on primitive races in India. In 1935, he was awarded the degree of Doctor of Philosophy by the Cambridge University and in 1933, worked for some time at the London School of Economics under Prof. B. Malinowski. In 1935, he was appointed to a temporary teaching post at Cambridge University. Dr Majumdar returned to India in September, 1935 but in 1937 went to Europe again to deliver a series of lectures at certain continental centres on primitive races and culture. He worked for a few months at the Galton Laboratory, University of London, where he learnt recent statistical techniques and also did some work in anthropometry, genetics and craniometry. His publications include *A Tribe in Transition* published by Longmans Green & Co., *Culture Contacts and Acculturation* and a large number of original papers on various anthropological subjects in scientific journals in India and abroad.

DR T. S. TIRUMURTI

President, Medical and Veterinary Research Section

Born in December, 1885 Dr T. S. Tirumurti entered the Madras Medical Service in 1909. After serving for sometime in the pathology department of the Madras

Medical College he was for a few years Medical Officer in the districts. In 1921 he was appointed Professor of Pathology in the Madras Medical College. He continued in the teaching line onwards occasionally reverting to medical duties in districts. After officiating as Principal of the Medical College, Vigagapatam and Chief Medical Officer for Harbour he is now the Principal of the Stanley Medical College, Madras. Besides his close connection with the Madras University he officiated for sometime as the Vice-Chancellor of the Andhra University and represented the University on various occasions. He was a member of the Bombay University Triennial Inspection Commission. He is the Vice-President of the All-India Medical Association and has been connected with the medical research bodies of the country. He is a fellow of the National Institute of Sciences, India and Indian Academy of Sciences, Bangalore.

PROF. S. K. ROY

President, Geology Section

Born on the 1st of January 1895 at Kurulgachi (Nadia, Bengal) Prof. S. K. Roy had his early education at Bawali and Bhawanipur. He graduated in 1916 from the Presidency College, Calcutta, where he had his initiation into the science of geology under the late Prof. Das Gupta, one of the pioneers of geological teaching in India and also under Drs. Cotter, Brown and Jones. From 1918 to 1919 he worked in the Forest Department of Bengal. In 1920, he joined the University and Technische Hochschule, Zurich, and obtained the Ph.D. degree from Zurich University in July 1924 on his thesis on "Geological and petrographic studies in Hercynian Mountains around Tiefenstein, Southern Black Forest, Germany."

Subsequently he joined the Zürich University as an assistant to Prof. P. Niggli and worked with him till march 1926. He co-operated with Prof. Niggli in the publication of the second volume of his famous mineralogy text book. During this period, at the request of Dr Amsler and under instruction from Prof. Niggli he reported on a gold deposit in German S. W. Africa. He was offered in 1925 the post of the Chief Geologist, Kutznetzk coal-field, Siberia, but he did not join the post.

After serving as State Geologist in Bansda State (Bombay), in the Mandi State (Punjab), since January 1928 he has been the Professor and Head of the Department of Geology, Indian School of Mines, Dhanbad. He is actively connected with the geological and allied scientific bodies of India like the Geological, Mining & Metallurgical Society of India, Mining, Geological & Metallurgical Institute of India, Indian Academy of Sciences and Indian Society of Soil Science.

During the period of professorship, he has carried out many researches in collaboration with his assistants and students. They include pioneering work in Nappe Structure in the Himalayas of Mandi State and the study of the ores from Nickel-Cobalt deposits of Nepal, Singbhum Copper Deposits and Burma Lead Zinc deposits under the ore microscope; the sedimentary petrological studies of the Jharia and Raniganj coalfields, and the prospecting and origin of the mica deposits of Bihar. Researches in his department have contributed to our knowledge about the heavy minerals of the Gondwana coal measures and most of our scientific ideas about mica-deposits.

MR N. SUBRAMANYAM

President, Geography and Geodesy Section

Mr Subrahmanyam graduated from Pachaiyappa's

College, Madras, and Government Training College, Rajahmundry, taking his Master's Degree later on. He started as teacher of Geography in 1906 and has been a member of the Madras Educational Service, training Teachers of Geography for the past fourteen years. A generation of Geography Teachers has passed through his hands and his work has been bearing fruit in the increasing efficiency of Geography course in South India.

To him the science of Geography owes a deeper debt of gratitude than to any other of her devotees in South India. By means of its quarterly journals, annual conferences, periodical Refresher courses and Summer Schools, District Studies in Geography, occasional excursions, Tamil Geographical Terms Committee and by collaboration with, and representations to, the Educational authorities, Mr Subrahmanyam and the Madras Geographical Association, of which he is the Secretary, have done an immense service to the cause of Geography in South India.

DR T. V. RAMAKRISHNA AYYAR

President, Agriculture Section

Born in 1880 in Tarakad village, Palghat, Malabar District, Dr Tarakad V. Ramakrishna Ayyar received his early education in the Victoria College and Native High School, Palghat. He graduated with distinction from the Madras Christian College in 1898. Mr Ayyar entered life first as a teacher in the Rajah's College, Cochin. In the year 1904 he began his career as an Entomologist when he was appointed as the first assistant to the first Entomologist to the Government of India. In the year 1906 his services were transferred to Madras as Senior Entomological officer when entomological work was started by the Agricultural Department in the Madras Presidency. In 1920 Dr Ayyar was appointed Assistant Entomologist and when the Research Institute was separated from the Agricultural College he was made Lecturer in Zoology and Entomology, a post which he held till 1930 when he was made Government Entomologist. He was elected a fellow of the Zoological and Entomological Societies of London many years ago.

In 1927 Dr Ayyar travelled abroad visiting Ceylon, Japan, China, United States of America and Europe acquainting himself with the progress of entomology and allied sciences in these countries. While in America he qualified himself and received the Ph.D. degree of the Stanford University, California, in Zoology—his thesis for the same being a hundred page memoir on "INDIAN THYSANOPTERA" which is now considered as the standard pioneer work on this group of insects in India. Prior to his retirement he was honoured by Government with the title of Rao Sahib.

Dr Ayyar is a pioneer worker in agricultural entomology. His notable contributions are on the insect groups *Thysanoptera*, *Hymenoptera* (specially parasites) and *Ryncohta* (*coccidae*). He is the author of 120 papers. He delivered the Maharajah of Travancore Curzon Lecture on Agricultural Zoology in 1937. He is a foundation fellow of the Indian Academy of Sciences, Bangalore and is a member of the University Board of Studies in Zoology.

PROF. N. M. BASU

President, Physiology Section

Born in April, 1892, at Midnapore Prof. N. M. Basu passed the Entrance Examination in 1906 from the Midnapore Collegiate School, and passed the M.Sc. Examination in 1913 from the Presidency College

Calcutta, standing first in order of merit in Physiology. He joined the Provincial Educational Service in 1914 as a demonstrator of Physiology in the Presidency College and later became the Assistant Professor of Physiology. He has published several papers with the co-operation of his students. He is the author of some 18 original papers.

Prof. Basu was largely instrumental in the foundation of the Physiological Society of India which he piloted as its Secretary with conspicuous success for nearly three years after its inception. He has now been working under the Indian Research Fund Association with regard to the determination of the state of saturation of Bengalee boys about vitamins C and B_1.

MR H. P. MAITI

President, Psychology Section

Born in 1892 Mr H. P. Maiti, lecturer in experimental Psychology, Calcutta University, was educated in the Scottish Churches College, Calcutta, and later in the Calcutta University from which he took the M.A. degree in Philosophy in 1916, and again in Experimental Psychology in 1918. He won the University gold medal and was appointed lecturer in the Psychology Department of the Calcutta University in the following year. He was president of the Psychology section of the Indian Philosophical Congress in 1934 and also of the All-India Convention for the Teachers of the Deaf in 1936. He was elected President, Child Education Section, All-India Teachers' Conference, 1937, and Mewar Teachers' Conference, 1937.

He is editor of the *Indian Journal of Psychology*, a member of Council, Indian Psychoanalytical Society and Institute, member, Indian Psychological Association, Secretary, Indian Association for Mental Hygiene, Calcutta, and is associated with many educational and psychological organisations. His research contributions are mainly in the field of perception, memory, endurance and work, intelligence testing and scientific measurement in education. He made a special investigation of vocational preference of college students and is now carrying on one in Intelligence testing.

DR K. D. BAGCHEE, D.Sc. (London)

President, Botany Section

Dr K. D. Bagchee is the Mycologist at the Forest Research Institute, Dehradun.

is due to the tidal action of the moon on the earth's conducting atmosphere. As to the solar diurnal variation, the most comprehensive theory so far advanced is the so called 'dynamo' theory first suggested by B. Stewart and worked out by Schuster. According to this, the electromotive forces are produced by a semi-diurnal horizontal oscillatory movement of the conducting upper atmosphere across the vertical lines of forces of the earth's field. The pressure variations causing the oscillatory movements are of the same types as those manifested in the barometric variations at ground-level. It has been recently shown by Pekeris that if in the stratosphere, there is an increase of temperature from 35 to 60 km. and a decrease thereafter up to 100 km. the atmosphere will have two systems of oscillation, one of which has a free period of approximately 12 hrs. and as the daily solar action has a period of 24 hrs. the sub-period of 12 hrs. is selected out for amplification. Pekeris has also shown that the amplitude of the 12-hourly wave at 100 km. is nearly 200 times that at ground level and that at 200 km. the tidal oscillations will be rapidly damped out by conduction and viscosity.

In the phenomenon of radio fade outs, the disappearance of the signals takes place quite suddenly over practically the whole of the sunlit hemisphere and is associated with the appearance of a bright eruption on the sun's disc. A characteristic magnetic disturbance accompanies the fade-out and an analysis of these disturbances show that they are distributed over the earth in nearly the same manner as the solar diurnal variation at the same local time. Ionospheric investigation shows that the main changes during fade outs are an increase in the ionisation in and below the E-layer.

These and other general considerations shows that the seat of the solar daily variations is in the E-layer and its neighbourhood. From magnetic variations, Schuster and Chapman estimated the direct current conductivity of the diurnal variation layer to be of the order 10^{10} e.s.u. while the conductivity calculated from ionospheric data by Appleton and others was $10^{11}-10^{12}$ e.s.u., if the oscillatory movements in the upper atomsphere were assumed to be of the same magnitude as those calculated from surface barometric variations and the conductivity in the E region were due solely to electrons. Pekeris's correction will increase the conductivity to $10^{13}-10^{14}$ e.s.u. Even this is too small. Massey's recent work on atomic processes in the upper atmosphere shows that in the E-layer the number of ions should exceed the electrons in the ratio of about 100: 1 and if this is accepted, the calculated conductivity will be of the right order of magnitude.

There are still discrepancies of phase between the oscillations required by magnetic data and those required by ionospheric data. Further work has to resolve them.

The time-variations of the magnetic elements after the onset of a storm can be analysed into (1) a storm-time variation and (2) a local time variation. Magnetic storms often begin with a sudden change in the horizontal component of the field simultaneously all over the earth- generally an increase followed by oscillations. Within an hour or two after this "sudden commencement, follows a period of rapidly diminishing H, lasting for 6 to 12 hrs. The period of abnormally low value of H is the second or 'main phase.' Finally, there is a gradual return of conditions to normal, which may go on for three or four days.

The storm-time variations can be analysed in a manner similar to the diurnal variations by the method of spherical harmonic analysis in order to ascertain whether the source is internal or external. The result of such a study is to show that the main source of disturbance lies outside the earth with an internal induced system associated with it. The distribution of disturbance over the earth shows that the external current system required to explain the sudden commencement and initial phase of the storm is an eastward flow all round the earth with maximum intensity over the equatorial regions. The current system due to the main phase can be analysed into (1) a westward flow with a diffuse maximum of current density over the equator and a concentrated maximum over the auroral zone and (2) a system of four vortices two in the northern and two in the southern hemisphere, one in the forenoon and the other in the afternoon portion of the earth. The afternoon vortices are generally the more intense.

The variation of field in and near the auroral zone during the main phase shows that the concentrated current flow in that region is situated in the earth's atmosphere at heights which have been variously estimated as lying between 100 km. and 600 km. The most recent work suggests a height of 100-150 km.

The maximum total current flow in the auroral regions in intense magnetic storms may be of the order of a million amperes..

The equatorial current systems—eastward in the initial and westward in the main phase of the storm—have to be assigned a location outside the earth's atmosphere. The hypothesis that they are ring-currents round the earth at a distance of 3 or 4 earth-radii seem to fit the facts fairly well. The recently observed effect of magnetic storms on cosmic-ray intensity also requires a deflecting agency well outside the earth's atmosphere. The variation of this effect from storm to storm indicates that the ring-currents can flow at different distances from the earth.

Theories of magnetic storms and aurorae are then discussed, particularly, the theory of Birkeland and Störmer that they are due to the projection of charged particles from the sun and the movement of some of them towards the earth in well-defined orbits depending on their speed, direction of approach and the magnetic moment of the earth. One of the possible orbits of such particles is in the form of an equatorial ring round the earth.

The existing knowledge regarding the changes in the ionosphere due to magnetic storms is reviewed and, the need for extending such studies to lower latitudes emphasised.

Chemistry

Analogy Among Chemical Elements and Radicals

—P. B. Sarkar

Analogy has played a significant rôle in the development of science. In chemistry, the method of analogy has been even more fruitful than in other sciences. Chemical analogy among elements revealed by the Periodic Law of Mendeleeff enabled him to predict the discovery of new elements.

Chemically similar elements attract the same radicals with proportional intensities of forces, whereas chemically unlike elements attract them with unlike intensities. The cause of chemical similarity lies in the similarity of electronic structure of the valence shells. The valency shell of thallium shows certain points of resemblance and difference with the valency shells of alkali metals like rubidium on the one hand and silver on the other, to either of which the element shows chemical similarity in properties of its compounds. For similar reasons, scandium resembles the rare earths in some of its compounds while in others, it is close to the elements of the iron family.

The entire series of the rare earth elements, from lanthanum to luteeium, is characterized by identical structure of the ultimate and penultimate shells of all the members. This is the reason for their remarkably close chemical analogy which rendered the problem of isolation of the individual rare earth elements extremely difficult to the investigators. Their separation by elaborate fractional crystallization has been possible because of their isomorphous character, as isomorphous substances rarely form non-separable mixtures on crystallization. The method of X-ray spectroscopy developed by Mosely and the interpretation of the Periodic Table by Bohr also greatly helped the identification of each individual rare earth elements as a separate entity.

Trivalent bismuth has been observed to show many similarities with the rare earths. Isodimorphism of hydrated bismuth nitrate with the rare earth nitrates and the isomorphism of the double nitrate of bismuth with the corresponding compounds of the rare earths have been utilised for the isolation of pure europium, fadolinium and terbium by Urbain.

Different classes of ions of identical outer shells naturally exhibit close analogy among themselves. A new classification of all the known ions can be made on the basis of the ratio of the ionic charge to its radius. The importance of ionic radius have been emphasized by several workers like Cartledge, Grimm and Hevesy. The importance is particularly evident in the case of analogous complexions, besides equality of charge and number of their constituent atoms.

Analogy among radicals is generally judged by their power to form isomorphous compounds with the same opposite ion. Hence isomorphism often serves as a criterion of chemical analogy or homology among radical or complex ions. But Mitscherlich's law of isomorphism, if restricted only to similar crystalline form, is not always a reliable guide. The law implies,

at least in the case of syncrystallization, equality of molecular volumes, equality of coefficient of dilatation, compression, as well as equality of molecular heats. These relations bring into relief the importance of energetic coefficients in matters of chemical analogy. Starting with the theory of Duhem, it can be shown by thermo-dynamical treatment that syncrystallization implies equality of all thermoelastic coefficients. Substances capable of forming mixed crystals must, therefore, possess very closely similar chemical properties. Besides similarity in crystalline form, the ability for syncrystallization should also be taken into consideration in deciding upon chemical analogy among radicals and compounds. Owing to polarization effects, many substances are found to give rise to homeomorphous crystals, yet do not form mixed crystals and are not chemically analogous. For the purpose of chemical analogy, the conditions of real isomorphine must be satisfied, one of which is the formation of mixed crystals.

Interesting cases of homologous radicals are sulphate and chromate, sulphate and selenate, and sulphate and manganate ions. The fluorosulphonate ion shows similar chemical anology with the perchlorate ion. The difluophosphates and perchlorates are also analogous. The flouberyllate ion is closely anologous to the sulphate ion in structure, and in physical and chemical properties of its simple and more complex compounds. The monofluophosphate and the sulphate ions form another isosteric and isoelectric analogous pair. There are also interesting points of analogy between the formate and the nitrite ions.

The three essential factors determinative of chemical analogy are (1) equality or ionic charge or valency, (2) similarity of structure, and (3) approximate equality of ionic radii. Of these, the first is the most important, and demands complete equality, or identity both in magnitude as well as in sign; whereas the last two permit slight deviation within a narrow range. Analogy is perfect when the latter two are also very nearly equal.

Geography and Geodesy

The Geographical Personality of India

N. Subrahmanyan

India is not a mere geographical expression but is a geographical personality, characterised by natural frontiers; by unity of climate, which is hot and monsoonic, due to her situation and configuration; and by unity of civilisation and outlook of her ancient and long-settled people. Nature has given India self sufficiency and isolation; and due to these conditions, there have resulted toleration and simplicity, subjectivity and stressing of the spiritual side of life; as well as stability and infinite variety—all which are features of Indian life. A cultural mosaic has developed but there has also been a cultural lag in the Modern Period. India was not behind Europe until seventeenth century. The Europeans, by their devotion to creative knowledge, have won since then new power and mastery over matter, and there-through have outclassed India.

But now, world influences have been pouring into India, mainly through Britain; and many an old feature of Indian life is fast disappearing. New opportunities are opening in India; and the bread that they would give could be retained by Indians, were there available to their entrepreneurs, adequate scientific knowledge and technical skill, along with organising ability and discipline. Actually, the vast Indian market is supplied by the Japanese, the Germans, the Italians, etc.

The Gandhian epoch, emphasizing human values, would rescue man from being swamped by machine. But the Factory is winning and under the double attraction of cheap Indian labour and protection policy of Indian politics much more capital than ever may flow into India from abroad.

In big industries, the Textiles are expanding, Iron and Steel settling down; Paper is growing up, while Cement and Sugar meet all Indian needs. Coal and Hydro-Electrics supply completely the Indian demand for Power, though the companies are not yet all Indian owned. The Mysore State has set the example of planned and correlated industries.

While world-contacts have been quickening Indian life, there are also momentous problems presented by them. Indigo, a former Indian monopoly, has been wiped out of existence by German synthetic dyes. New producing countries are springing up as in Africa, threatening Indian jute. There is disequilibrium set up by political action such as economic nationalism; Ottawa Preferences; barter systems; tariff walls; etc. New production centres in India further tilt the balance.

In this modernisation of India, the regenerative forces are communities, institutions and individuals.

The British have had the largest influence of any, by virtue of their commanding place in India. In the several aspects of British character, each province has sought and found what suits best its genius loci.

Indian universities, founded on that of London of mid-nineteenth century, have just begun to awaken to the need of creative knowledge, thanks to the genius and energy of the late Sir Ashutosh Mookerji.

Sports and Science—sports played in the sportsmanlike spirit and education in science imbibed in the true spirit of science—hold out great promise for India, bitten as she is all over with many a virulent position.

Among individuals making Modern India there have been giants in the Past and the Present—British and Indian, and others, who have brought to their inspired labours a great vision and love of India. The efforts of the countless many as well as theirs are visible in the good works already achieved in Modern India. It is specially noteworthy that any Englishman 'does' in India.

Of the men of the West, the Eighteenth century welcomed the soldier of fortune; the Nineteenth, the business man; but the Twentieth welcomes the technicians that, like the Germans, are really skilled and ready and willing to work under the Indians and to teach them, too.

The British rulers in India, however, differ from previous rulers in that they do not settle in India. Coming in relays in their prime, they flit about and retire in middle age. India thereby suffers a double loss, a loss of their Indian experience and loss of their example and leadership in the civic and political life of India. Unlike the British, the Moslem rulers settled in India and have made India their home. Accordingly, they form part and parcel of the population. And in all Indian affairs, they play their part, have their say and a weighty one at that. For centuries, the Hindus and the Moslems have been living side by side, retaining their distinctness, but influencing each other in architecture, painting, and other fine arts; and evolving a common music, language and literature as well as a common outlook. The levelling influence of Islam has found full scope where the Moslems are in numbers.

Moslem culture belongs, in essence, to the Middle Ages and derived from West Asia. British culture belongs to West European and is modern.

And its influence upon both the Hindus and the Moslems of India is profound, not the less so because unenforced. English Language and Literature, English Life and Thought, have been moulding modern India in all activities of life and creating not servile imitations but new evolutions and adaptations of old modes.

Religion (as in Dayalbhag) and Politics (as under Gandhiji's lead) furnish motives to many a successful achievement in Modern India, in spite of adverse conditions. There is plenty of room even for the mere capitalist.

It will be seen that India is in transition from the old to the new; from mediaeval to modern conditions; from one culture to another. The West have outgrown those times by their devotion to creative knowledge and reliance on self-help and self-sacrifice, and the spiritual side of their being. India, too, will give up looking for a *deus ex machina* for all things and rely on own spirit.

The old static Geography sees only the pressure upon land, the appalling poverty, etc., of an improgressive India. The new dynamic Geography can see the forces at work, and disengages the true causes from the false. It finds that the causes are not inherent but removable; that man in India has fallen behind and is catching up; only, he has not, as yet risen to the height of his opportunities.

Here, in India, all the cultures of the World meet, in all their variety and range; and a great composite civilisation is growing under the influence of them all.

Therein will lie the diversity, richness, comprehensiveness and greatness of the Indian civilisation that is to be.

England is the synthesis of northern Europe; the United States is the synthesis of all Europe. India is to be the synthesis of the whole World.

Botany

Indian Forest Mycology with special reference to Forest Pathology

—K. D. Bagchee

In this paper, a summary is given of mycological research in the Forest Research Institute, Dehra Dun. The investigations on tree diseases and associated problems are discussed under six heads, namely, (*i*) Coniferous rusts, (*ii*) Root-and-stem-rooting fungi, (*iii*) Canker pathogens, (*iv*) Nursery diseases, (*v*) Timber diseases, (*vi*) The ecology and habits of forest fungi, commonly growing on the floor of the forests which have been summarised separately in each of the following paragraphs.

The study of the Indian coniferous rusts is important because of the necessity of protecting young coniferous plantations, nuclei of potential forest wealth, from the ravages of fungal parasites. Previously only eleven coniferous rusts were known, the morphology of which was incomplete, and on the biology of which no work had been done. Now to the old list of rusts, four more are added, bringing the total up to fifteen out of which eleven have been matched and three proved to be microcylic, while one yet remain unmatched. Working out the biology of the rusts and placing them in their proper generic grouping is a straightforward process, but difficulties arise when they have to be fitted into the catalogue of rusts with reference to the European species. It has therefore been suggested, after citing instances of *Cronartium ribicola* and *Coleosporium campanulae*, etc., that the final naming of a rust should be deferred until the biology has been fully worked out, if the name is given on morphological grounds only, such illogical discrepancies are likely to occur.

It is claimed that although the two *Polyporaceous* fungi, *Ganoderma lucidum* and *Polyporagilvus* were supposed to be responsible for the disease of shisham, they only play a secondary part; a species of *Fusarium* being the main causative factor of the disease in each case. Instances of similar association of ascomycetes with basidiomycetes causing canker diseases of Indian mahogony (*Pterocarpur marsupium*), (*Acacia catechu*), babul (*A. arabica*), and rosewood (*Dalbergia latifolia*), of *Fusarium* wilt disease of several other forest trees, such as mahogony, teak, *Erythrina* etc. are cited. A detailed discussion of various other bracket-fungi, namely *polyporus shoreae*, *Tramates incerta Fomes tricolor*, *Fomes melanoporus*, and *Fomes fastuotus* follows, in connection with the unsoundness and the disease of sal. Fungi like *Fomes annosus*, *Armillaria mollea*, *Trametes pini* etc. causing coniferous diseases are also discussed, along with the factors which predispose their hosts to infection. The view put forth is that the chief of such factors is the fluctuation in acidity in the soil, which in the case of natural regeneration is due to an accumulation of humous in the upper layers of the soil because of the annual growth of weeds. In case of plantations, this is due first to agricultural terraces and cut over forest lands, and secondly to the growth of weeds in the early stages of regeneration.

After dealing with canker pathogens with some instances of canker organisms on a large number of hosts, both native and exotic species, Dr Bagchee proceeds with nursery diseases, when damping off and wilt are discussed. They are taken to be the result of the fluctuations of the hydrogen ion concentration in the nursery soil. The pH value of soil fluctuates greatly between the driest and the wettest periods in the forest nurseries in the plains where cultural operations of the hardwood spp. are carried out. High temperature during the driest period of the year which bakes the surface soil injuring the roots, and high humidity following it are held to be the main factors leading to the incidence of damping off. Fungal pathogens are also described, affecting the nursery stock, and belonging to various species of *fusarium*, *Rhizoctonia*, *Corticium*, *Pythium* and *Botrytis*. Discussing seed-borne parasites investigations about which are undertaken to certify that seeds for export are free from injurious organisms, it appears fungus pests so far identified are mostly *Deuteromycetes*. Examination of root-and-shoot-cutting (*truncheon*) method to propagate various hardwood species often shows the presence of several common wood rotting fungi belonging to the *Basidiomycetes*.

Suggestion is made of the possibility of controlling tree diseases by means of the co-operation of other sister sciences' like plant-breeding, soil physics, soil chemistry and soil microbiology. The difficulty of controlling forest diseases is referred to as being almost insurmourtable because of the innumerable hosts

and parasites, not to speak of permutations and combinations, and insufficient resources.

Timber pathology has recently gained prominence in connection with good preservation and the toxicity tests of wood treated with preservatives. Many *Polyporaceous* fungi and also some dry-rot organisms are being used for testing toxicity. The behaviour of these wood rotting organisms and their reaction to the chemicals used as preservatives, as well as the character of the rots of different organisms under different conditions are related to have afforded an interesting line of study. The many difficulties in the testing of toxicity gradients of wood preservatives are pointed out.

Regarding common forest fungi from an ecological point of view instances are cited illustrating how the mode of life and behaviour of the same organism under different circumstances, or of closely related species under the same conditions, are surprisingly different. The habits of some other fungi also are described, as giving an insight into the character of the soil suitable for various kinds of forest.

Zoology

Batrachians and their Environment

—C. R. Narayan Rao

Professor C. R. Narayan Rao's address is based on the data accumulated by his faunistic studies of the batrachians of South India, and is an exposition of the interrelations of the environmental complex and their general morphological organisation, producing marked effects on somatic and genetic variations. Ecological communities of amphibians can be recognised which resemble each other superficially in correspondence with resemblances between their environments. The tailless amphibians inhabiting the rain forests of the different parts of South India are reported as exhibiting a whole series of obvious resemblances, among which adaptational modifications for climbing, burrowing, crawling and for parachute leaping are especially noteworthy. Batrachians and their larvae affecting the rapid hill streams where they periodically encounter floods, have developed adhesive discs for firm attachment to rocky surfaces or as in the case of larvae are provided with organs of flotation as well. According to Professor Rao the necessity for definite adaptational devices operating upon this plastic group of lowly organised animals form a sort of wicket gate through which only forms possessing similar adaptations can pass, thus giving rise to common morphological features of batrachians living under more or less similar environmental conditions. The warm air saturated with moisture in the tropical forests renders the ghats an ideal place for the occupancy of amphibians and the physiological influence of factors such as the varying amplitudes of temperature, humidity, intensity of light, air pressure, food, and the presence or absence of plants, produces significant regulative modifications both in the character of structural organisation and general habits. To illustrate the extent of such modifications, the common toad and the common water frog, which occur in the plains and which have extended into the deeper regions of forests and the summits of the higher ranges of hills, have been selected and the limits of variations have been noted. There is an astonishing profusion of amphibian life in these regions, and the members of the different groups present common characters and common habits which have resulted under the influence of common environmental factors, and Professor Rao indicates that so close is the correspondence that without recourse to anatomical examination their classification offers perplexities. According to him ecological studies of amphibians in their morphological and physiological aspects throw considerable light on the problems of their taxonomic relationships, rendered complicated by the frequent occurrence of interbreeding among the members of the different genera and by the presence of hybrids closely intermingling with the natural species. The suggestion is made that spatial distribution of the members of an original stock into regions totally different in physical characters, aided by the process of selection may be presumed to be the stimulating factor in the evolution of new species.

(*Abstracts of other presidential addresses will appear in the next issue*).

Address of Rao Bahadur K. N. Dikshit, President, Calcutta Meeting of Numismatic Society of India

After paying tributes to the memory of late Mr N. G. Majumdar who as the Superintendent of the Indian Museum took keen interest in numismatics and was probably the most distinguished among the younger generation of Indian archaeologists, he proceeded

"The Numismatic Society of India has had its publications brought uptodate by having two numbers, one the Numismatic Supplement No. 56 and the other the Silver Jubilee number, brought out along with an index and a small pamphlet giving short notes about the work and photographs of the founders of the Society. The progress of numismatics during the last generation has been summarised both in the Numismatic Supplement by Messrs. G. V. Acharyya and R. G. Gyani and by me in my contribution to the volume entitled. *Progress of Science during the past 25 years* brought out at the time of the Silver Jubilee session of the Science Congress. After this any further attempt to give a resume of work in the field of Indian numismatics is, I think, unnecessary. I may, therefore, pass on to indicate the lines on which the work in Indian numismatics should be carried on and some of the practical steps that the Society may take to extend the knowledge of numismatics and to attract young workers into the field.

Our meeting in Calcutta here after nine years can itself be taken as a subject in which we may learn some useful lessons. At the time of the last meeting a large number of people joined the Society which gave us the hope that Bengal will in future contribute a substantial share of research in numismatics. This hope has, however, been falsified, and after nine years we again find that the number of the Society's members in Bengal is probably as low as it was before 1929. The reason is not far to seek. The fact is that the Society's meeting in Calcutta gave a temporary stimulus to scholars interested in numismatics, but in the absence of any permanent focus at this perhaps the most important centre of research in India, enthusiasm gradually waned away. My first suggestion is, therefore, that the Society should create and recognise regular local centres in such places like Calcutta, Bombay, Madras, Lucknow and Lahore, where a local Branch Secretary should be regularly appointed to organize the work in communication with the members in that centre. In Bombay, the local members do meet at times but there is no reason why this effort should be confined to that city. If possible, a scholar connected with the Provincial Coin Cabinet at these centres should be associated with each local organization, so that there will be ample scope for research for the local members. More scholars and research workers may thereafter be induced to devote themselves to study definite branches of Indian numismatics, particularly if facilities are provided by the officers in charge of the public cabinets to genuine students and scholars approved by the Society.

In regard to the award of prizes and medals by the Numismatic Society of India I should like to make some suggestions with a view to enlarge their scope. Perhaps young scholars may be encouraged to take up the study of Indian numismatics, if a cash prize or scholarship were to be occasionally awarded for the study of a definite branch of Indian numismatics. The funds at the disposal of the Society may enable them to institute such a scholarship at least for one year. The student should be made to work under the guidance of a competent numismatist, working at one of the principal Coin Cabinets in India. Another direction in which the knowledge of numismatics may be spread is the preparation of standard works on ancient coins in the different languages of India. For the present I would suggest that a book in Hindi and in Urdu on the lines of the late Mr R. D. Banerji's Bengali work "*Prachin Mudra*" be written by two competent scholars, which should be awarded prizes by the Society.

One of the most important fields of Indian numismatics in which much systematic work is to be done is the preparation of a corpus of coins of the period after the Gupta Empire and before the commencement of Muhammadan rule. This is a fit subject for systematic research for a number of years, and I invite the attention of scholars to the need of organizing it. We know how the disintegration of the Gupta Empire after Skandagupta was reflected in the scattered and disconnected monetary issues of the sixth and seventh centuries A.D. The degeneration of coinage continued

still further in the succeeding five centuries and it is interesting to see how in this period which saw the rise and downfall of so many dynasties of more or less local or provincial importance the moneyer's art touched the lowest watermark. Another subject fit for a Monograph to the study of conage and coin weights from the earliest times to the modern period. At present this study is confined to the metallurgy of different classes of coins, but no standard work devoted to this subject alone giving a comprehensive and historical review is available to the student of numismatics.

Coming to the more recent discoveries I may here refer to the remarkable way in which epigraphy and numismatics have within recent years combined to throw light on a hitherto unknown dynasty that ruled over the Baghelkhand and the lower Gangetic *doab* regions about the 3rd-4th Century of the Christian era. Several kings with names ending in *magha* were known from inscriptions discovered in the region of Kosam near Allahabad to which another king named Vaisravana was added by the discovery of the late Mr N. G. Majumdar which was made at the last place. Further epigraphs of this king were discovered at Bandhogarh in the Rewa State and recently Mr Murari Lal of Benares has been able to secure a large hoard of coins from Fatehpur which is to be attributed to Sivamagha and other *magha* kings, as also Vaisaravana. The use of the Kalachuri era in this series of records makes it highly probable that the era began in the Chedi country and for some still unaccountable reason it was next found in the Traikutaka records on the west coast. This is yet another proof of the fact that the age of discoveries in the field of epigraphical and numismatic research is by no means over.

The study of punch-marked coins is gaining rapidly in volume and extent. Besides the indefatigable researches of Mr Durga Prasad of Benares, we have now a systematic and intensive work by Mr Walsh on the punch-marked coins of Taxila. The latter, along with the Catalogue of punch-marked coins from Purnea discovered as a treasure trove some 20 years ago is now being published as a Memoir of the Archaeological Survey of India. I may also refer to the discovery of punch-marked coins found in the excavations at Kasrawad in the Indore State where a Buddhist establishment of about the Mauryan period has been for the first time found in Central India. Day by day evidence is accumulating that the extension of the Mauryan sovereignty over widespread parts of the country (from Peshwar to Dacca on the east and Mysore in the south) was accompanied by the spread of the standard coinage known as punch-marked which itself originates from an earlier date. It is yet too early to attach definite values or significance to different symbols occurring on coins from definite localities. I may here suggest that an exhaustive study of the cast coins, which were certainly issued from regular mints should yield important results. Regional studies of the early issues of cast coins would form a very interesting line of research and one in which our younger members in the various centres can in a large measure co-operate.

The widespread range of another type of coins labelled as tribal, *viz.*, that of the Yaudheyas makes it probable that the leaders of this tribe established a farflung dominion over eastern and southern Punjab, North Rajputana and western U. P. in the 3rd Century A. D. Besides the discovery at Rohtak of a large number of coin moulds, which has been fully described by Dr Birbal Sahni, a number of coin moulds of the Yaudheyas have been reported from the ancient site of Sunet near Ludhiana. Several large hoards of Yaudheya coins have been found in course of excavations at the site of Theh Polar in Karnel District on the banks of the Sacred Sarasvati and at Rohtak a large number of specimens of a later variety of degenerate coins with a standing human figure also probably to be attributed to the Yaudheyas were found.

In the end I would appeal to the members of the Numismatic Society of India to devote their attention to the problem of increased tendency of sending important and unique coins abroad and thus denuding the country of its best material for research. The public collections in India can hardly compete with the private collectors in the open market owing to the very limited grants available to them for acquisition. Private collection, however important for increasing the zest for research, is likely to degenerate into a passion for making bargains to the detriment of the public cabinets in India. While commending private efforts in the field of numismatical research in every possible way, particularly by the encouragement of the formation of private collections, I feel it my duty to appeal to you as members of this Society that none amongst our ranks will at any rate lose sight of the interests of Indian public cabinets before disposing of their collections.

Agriculture

Insects and Their Role in Indian Agriculture

—T. V. Ramakrishna Ayyar

The Indian farmer has to solve many important problems if he ventures to succeed in raising a good crop with advantage; these include among others matters relating to the physical and chemical characters of the soil, the health and reliability of the seeds, and the satisfactory nature and vigorous growth of the plants. In addition to all such aspects, is the problem of the protection of these crops from their various animal foes. For, in spite of the best cultural attentions of the agriculturist, the finest manuring by the chemist, or the most uptodate methods of the botanist to raise a healthy and heavy yielding crop, it is within the power of some animal enemies of crops to undo all such laudable efforts by making one clean sweep of all the growing plants in any area, even within the period of a few hours! A prudent farmer will therefore do well to get himself equipped with some general ideas regarding the bionomics of at least some of the more important of these animal pests which levy a heavy toll on his crops season after season, so that he may be able to reduce at least some part of the havoc so caused. Under the category of man's animal associates we have various groups from the mighty elephant to the minutest mite each playing its part in the economy of man, the study of these relations being known as the science of "Economic Zoology". Of all such forms of life which have anything to do with the agriculturist, the miller, the grocer or the stock breeder, no single group of animals plays such a prominent role in a variety of ways as insects. Of the different aspects of insect activities the role they play in agriculture is the most important, since enormous damage is caused to growing crops and the farmers suffer heavy losses. Though the average farmer is only familiar with the occasional flights of locusts or periodical plagues of caterpillars, he is blind to many other forms of insects which silently but steadily levy a heavy toll on the agricultural products. According to Dr Ayyar's calculation, the annual loss, caused by insect damage to half a dozen only of our field crops, comes to 200 million rupees. From the damage caused by a single insect, the rice weevil, the loss has been estimated by a responsible officer to be nearly hundred million rupees. It is high time that Governments and scientific institutions should pay more attention to this menace. The organisation for this work all over India should be increased. A systematic and thorough study must be made of the bionomics of all pests especially from their ecological side, the relation of climate and weather to insects and of methods of production of cheap and effective insecticides locally.

A good deal of co-operation is essential between workers in the different branches of science and more attention has to be paid to the applied aspects of the natural sciences. There is need for specialisation on the part of different biological workers each in his own branch but a general knowledge on the part of each of the specialists of what others are engaged in will be of great advantage to all, as there arise numerous biological problems which call for co-operation and team work. In India the applied aspects of biology do not receive as much attention as they deserve even in the universities, where biology and zoology are included in the curricula of studies. It is on the foundation of agriculture that all human activities and thoughts depend in the last resort and agriculture is mainly applied biology. The last War and the events that followed have demonstrated with great force the absolute dependence of all phases of, industrial life upon agriculture. It might be pointed out to all interested in the agricultural prosperity of our land that the insect problems of the Indian farmer are increasing day by day and it is up to Governments and the educated farmers to do all that should be done to save the country from the clutches of noxious insects. Dr Ayyar concluded with Prof. Maskew's very apt remarks. 'The most important, the most vital thing in all the world is to get something to eat', and agriculture in its broadest sense is the source of something to eat, and the original source of all subsequent action. Applied agriculture in practically all lands now recognises that the greatest sources of loss to cultivated crops can be traced to the depredations of insect pests and plant diseases.

Anthropology

Cultures and Acculturation

—D. N. Majumdar

There are in India nearly 30 million primitive people, and they form approximately 8 p. c. of the total Indian population. There are many primitive tribes in this country that have declined in number or are showing a tendency to decline but there are also others who have gained in numerical strength. Some of them are under a protective system of administration, while most of them are governed indirectly through the tribal chiefs and are exempt from the operation of certain laws and enactments which are detrimental to their interests.

The depopulation that the tribal society is experiencing today in many areas is due to momentous changes in economic and social life brought about by contacts with civilisation. Important demographic consequences have resulted from the life and death struggle of many primitive tribes in India and elsewhere. A sort of moral depression has set in among certain tribes, and its effects have been disastrous to the vitality of the tribal stock. The tribes are indifferent to their own welfare, improvident and are unmindful of the health of their progeny.

Contacts of primitive tribes with civilisation must necessarily lead to miscegenation of culture. A group which has not lost its interests in life and possesses vitality must adopt traits from other groups. This adoption of alien traits is usually selective and it is on the nature of this selection that the future of the group depends. The process of selective adoption may be called acculturation. When several cultural groups coming from different geographical areas, meet and settle down in the same place, they react and adjust themselves to one another and may develop the closest co-operation. This process may lead to symbiotic relationship or fusion, as in the case of many tribal groups who have lost their tribal designation or have become assimilated to the Hindu social system represented by the caste. In such cases of cultural symbiosis or acculturation, reciprocity and mutuality of obligations play important roles which link section to section and produce interesting culture-complex.

Nowhere in India perhaps this process of symbiotic relationship or acculturation is more patent than in Bastar, an important feudatory State in the Central Provinces. The native population of the State are known to belong to the Gond race. The foreigners and immigrants who have settled in the State and who claim Kshattriya origin, are believed to have freely mixed with the native population.

Bastar has been for centuries a veritable melting pot of races and groups. A continual process of admixture has been going on and today all ethnic frontiers appear to have broken down and the various groups, tribes and castes, irrespective of their professions to the contrary, have little of racial purity and they are today cultural units in a great cultural zone. A comparison of the somatic characters of the various groups in Bastar fully coroborate this fact.

The infiltration of the caste people into aboriginal areas, where they are found to dominate the native population, has resulted in an interdependence of the two groups, so much so that the existence of one group without the co-operation of the other is extremely difficult. The Kabadi system prevalent in Bastar affords an example on this point. The dependence of the individual families divorced from tribal occupations has been real, so that their economic helplessness has become a source of their exploitation by the caste people. The idea of obligation of the tribal people and their honesty make it impossible for them to leave the master's service so long as they have not liquidated the debt and this may and very often means life-long servitude. When the debt remains unpaid and the man dies, his son has to take up the burden of debt on his shoulders and continue as a 'Kabadi' or life long servant in the master's family.

Again economic interdependence of the various groups has led to a healthy reciprocity in some aspects of cultural life. The institution of the Dusserah festival has brought together the various cultural groups of Bastar as participants in a great cultural

heritage. An analysis of the customary division of labour in the Dusserah festival of Bastar which is held in honour of Dhanteswari, the family goddess of the ruling chief of Bastar, shows how far the various tribes and castes co-operate among themselves in social, economic and religious life. In Bastar, the co-operation between the various cultural groups which do not appear to have maintained their ethnic identity is more real and the inferior cultural groups have not been denied important roles in the organisation and performance of the worship. While in the south, the economic partnership between primitive and backward groups has been regarded as essential but no serious attempt has been made to bring together the different groups into a common religious fold, in Bastar the fact of their cultural differences has been forgotten and there is one festival for all in which rites and customs of primitive and advanced cultures have blended together. If the tribes of Bastar have come into closest contact with the higher cultural groups who claim descent from the Kshattriyas, their own culture has not been tremendously upset by their association with the latter. Many of their indigenous institutions have survived and still fulfil some of the purpose for which they were introduced.

The principles which underlie the survival of social institutions are indeed numerous. An institution, if borrowed from an alien source, remains for a time unchanged. A cultural trait borrowed or indigenous also remains unchanged if it cannot be fitted into the existing structure of the society or if any change in form leads to maladaptation. The survival value of an institution is proportional to its utility as every cultural form is an instrument of adaptation. Its role is to render the process of adjustment of the group to its milieu as also of the intra-group adjustment, smooth and easy. An institution may survive through *the principle of graded utility*. This is how the dormitory institution among the tribes of Bastar has survived.

The dormitory institution is a group organization. Its origin may be traced to the campings where the ablest hunters of the community took their shelter for purposes of defence and protection of the weaker members but in course of time other traits have slowly been woven round it and the elaborate Gotul of the Murias is the result. With settled life and a better control of food supply, predatory excursions of neighbouring groups for women or for cattle become rare, but economy of accommodation in the house, helps to maintain this communal organization as the members find it a convenient place to sleep in and a venue for their communal activities. Association of men and women in the dormitory helps to make the group life vivid and concrete. Opportunities for inter communication between the members of the group sets up a group standard of social life. It is in the dormitory that a system of discipline may be rigorously tried and the success in this direction has contributed not a little to tribal and clan solidarity and often slavish compliance to traditional usages as we find in most of the primitive groups. Training of boys and girls in the usual economic pursuits characteristic of the group, in social and ceremonial duties, in sex and associated matters, is inculcated through the dormitory organization and thus it fulfils an important role in the tribal life of the community concerned. Above all, the dormitory institution where it exists, insures tribal endogamy by controlling the movements of women belonging to different tribes. How far this has been achieved depends on the effectiveness or otherwise of the dormitory organization.

Physiology

Physiological Research in India

—N. M. Basu

Prof. N. M. Basu in his presidential address on the physiological research in India discussed at the outset the scope of research in physiology. In analysing the various factors which are hampering the growth of research in this subject he showed that in both medical and scientific institutions where physiology is taught, the insistent complaint is inadequate staff, or insufficient financial provision, or both, in proportion to the number of students. Besides these, the following are amongst the various causes which have made physiology a subject of secondary importance in the chess-board of other sciences. (1) Due to the persistence of the old belief that physiology is still a hand-maiden to medicine and

the ignorance of its recent rapid advances, it is given an inferior position and is, therefore, receiving a step-motherly treatment with regard to provisions for its healthy and active growth, insomuch that even its existence is threatened. (2) On account of the absence of material prospects of the students of physiology, the subject is not popular amongst the best students and is accordingly taken up by boys who care more for the degree than for the subject. (3) Students taking up physiology do not either get an opportunity for taking up physics and chemistry or are not encouraged to do so, although a knowledge of these basic sciences is essential not only for its proper understanding but even more so for the initiation and conductance of researches. (4) Some laboratories were so constructed that no provision for research was even contemplated for junior members of the staff. (5) Physiology having not yet been released from the thraldom of medicine, or medical men who never specialised in this subject, it has a parasitic existence and its growth is accordingly hampered; and lastly, (6) the syllabus is too old, vague and inelastic either for the growth of studies or for the stimulation of research work amongst the students.

He then gave a review of the progress of research in physiology in this country and stressed the importance of some of these investigations from the point of view of practising physicians and practical dieticians, as detailed hereafter: the determination of various physiological norms, with regard to the constituents of blood, reticulocyte count, and Arneth count; the influence of drugs on coronary circulation; analysis of normal gastric juice; digestibility of oils and fats, of proteins and starch of pulses and rice and of proteins of fishes; determination of the biological value of proteins of pulses, different varieties of rice and fishes; determination of the basal metabolic rate and its climatic variations, and of the extent of malnutrition in some provinces by nutritional surveys and A. C. H. index; analysis of foods and losses during their cooking; assay of vitamins A and Carotene, B_1, B_2, B_6 and C in different foods, including fruits and vegetables; determination of available Ca, P and Fe and of oxalic acid in different foods; investigation of the effects of balanced diets on rats and groups of individuals and of supplementing deficient diets by such dietary essentials as were found lacking; and lastly the determination of sub-optional nutritional deficiency of boys with regard to various vitamins. Besides these Krishnan's work on intestinal movements, Basu's own work on crenation of red cells, Chopra's work on embryonic heart explants and electro-encephalographic studies deserve mention. As a result of researches, Bengal gram, black gram and green gram have been found to be superior to lentils with regard to biological value of proteins. Green gram is much superior to lentils in other respects as well, *viz.*, with regard to available protein content and the power of supporting growth. Further, green gram forms much better supplementary relations with rice than lentils.

It is also found that a diet of home-pounded rice, dal and vegetables with a small amount of animal protein, preferably milk proteins, is almost unassailable from the point of view of modern ideas of nutrition and is suitable in the tropics.

This comprehensive work regarding the various aspects of nutritional studies has been possible on account of the existence of some research institutes and a liberal supply of grants from the Indian Research Fund Association. If these researches are left out, the output of work in other branches of physiology is very small. This is mainly due to the absence of a central organisation, and want of funds. Prof. Basu accordingly pleaded for the establishment of a central organisation for researches in physiology side by side with that of pharmacology, for these two subjects are closely allied and interdependent on one another.

Abstract of the Presidential Address at the Lahore Session of the Indian Statistical Conference

Relation between the Statistician and the Community

—T. E. Gregory

Statistics has grown out of the necessities of the State and therefore it is necessary to deal, first with the relation of the statistician and the State. We are living in a dark age which threatens to become darker and it is the social sciences—from theology and biology to economics and statistics—which are most in danger. There is no longer merely a threat of the prostitution of science and the scientist. The process is in full swing. Unfortunately for himself, the scientist is a simple creature, happiest when he is left alone. But we as scientists can no longer take a passive attitude: however much we may deplore the maddening waste of time and energy involved we must fight not only for our right to lead our intellectual life as best we can but also for modes of social organization which include the spiritual value of truth and reason as among the intrinsic goods of life, about which there can be no dispute. Unfortunately, over a large part of Europe, the necessities of racialism and economic autarchy are poisoning the wells of truth, so far as statistical science is concerned.

The statistician, in his positive relations to the State asks for two things. First, the improvement of existing sources of information and the utilization of the services of the statistician in connexion therewith. Ample opportunities for the same will be presented by the forthcoming Indian Census. Secondly, aid in the provision of facilities for training and research—though it is dangerous to rely exclusively upon the State for this, as for any other educational objective.

Coming to the relation between statistics and the other social sciences, there is first, the danger that mechanical process, even of the most refined type, might be substituted for creative thought. Secondly, there is the danger that dogmatic social conclusions might be drawn from statistical data. An example of this is provided by the conflict between Pearsonian school of statisticians and the social biologists of the school of Hobhouse as to the precise social significance of certain enquiries pursued by the former, which seemed to imply that eugenics and a reactionary social reform policy were identical. Thirdly, there is the danger that statisticians should not be sufficiently alive to the limitations of the data and to the imperative necessity of careful definition, as for example, very varying consequences might be drawn from a decline in the "gainfully occupied" population compared with the total population.

The curse of the modern world is alarmism and sensationalism—vices not in the least confined to democratic states. But what could the statistician do about it? Two things: we need a class of popularizers of the calibre of Galton, Giffen, Chiozza Money, Lord Stamp and others who were both scientists and educationalists, and a thorough process of education—the public need to be trained to think of *scale* and *proportion*: at the same time, the urge for standardization would be assuaged if such statistical concepts as the mode, the decile and the quartile could replace the concept of the average in political and popular thinking. Statistical teaching of a simple kind might thus help to impose on the average man's mind the idea that variation is natural—a fact which certain schools of thought are only too anxious to make him forget.

indomitable will power. And in rapid succession he bought many "rotten" cotton mills on the verge of liquidation in Bombay and Ahmedabad and converted them into prosperous concerns. The secret of success lay in scrapping old inefficient machineries for production and equipping them with modern up-to-date plants, and above all in his uncanny gift, which amounted to genius, for selecting right subordinates. Throughout his life he exhibited to a notable degree the art of delegating much of his work to proper persons. He kept his fingers lightly upon the pulse of a business. There was no fuss, no unnecessary worry. When he once devoted his mind to ambitious projects or further expansion, he could call upon that reserve of time and energy which only a great organiser can keep at his disposal. He could do so the more easily as his worthy and well-trained lieutenants had helped him to build up a firm eminently fitted for expansion. Thus the major schemes with which his name will ever be gratefully associated were no doubt conceived by him; and in some cases, he even planted the first seeds, but it was only after his death that these schemes came to fruition. Such examples are rare in the history of any country, but they are rarer still in the history of India.

Like most men who have succeeded by their own efforts Mr Tata was sensible of the value of education and he determined to do all that he could in order to afford to others these adventages of which he himself had made the fullest use. He believed that much of the poverty around him was due to want of opportunity. He had experienced the waste which was caused by inefficient workmanship and was convinced that the application of science to industry was one of India's greatest needs. The inspiration came from Lord Reay, Governor of Bombay, who speaking in 1889 as Chancellor of the Bombay University, observed "It is only by the combined efforts of the wisest men in England, of the wisest men in India, that we can hope to establish in this old home of learning, real universities which will give a fresh impulse to learning, to research, to criticism, which will inspire reverence and impart strength and self-reliance to future generations of our and of your countrymen."

As preliminary to his long contemplated scheme which at length brought into being the Indian Institute of Science, he decided to send every year a few chosen students to England so that the much-needed cultural contact with the West could be just initiated. The funds of the Tata Scholarship scheme which was later augmented by his sons now amount to ten lacs of rupees. The bent of Mr Tata's mind was inclined towards scientific studies and he sent Mr Burjorji Padshah, who had been acquainted with him since boyhood and was an educationist, to England and the Continent for evolving a scheme which should be financed by him. Specialised study and research on medicine, on tropical vegetation, Indian archaeology and history, statistics and philosophy of science were separately advocated by distinguished men abroad. It was clear however from the very beginning that the endowment fund created by Mr Tata which would bring in a revenue of Rs 125,000/- a year was not sufficient to finance a well-equipped Research Institution, and Mr Tata sought the aid of the Government of India and of the Indian states for the furtherance of the cause so dear to his heart. The Mysore Durbar under the influence of Dewan Sheshadri Iyer promised an annual contribution of Rs 50,000/- and an initial capital grant of Rs 5 lacs on condition that Bangalore was selected for the location of the Institution. But the wheels of the Government of India moved very slowly and Prof. Sir William Ramsay, the celebrated chemists was invited to come to India in 1901 to finally examine the scheme. He stressed on the ideal of a research institute where eminent professors would by their researches 'help to create new industries and reform the old.' To him, finance was the key to the whole situation, and he felt that it would be folly to launch the scheme until its financial future were assured. He selected Bangalore as suitable site partly because of its excellent climate and also because of the generous financial support promised by the Mysore Durbar. The subsequent negotiations with the Government of India read like a tale of long-drawn agony. It was only the death of Mr Tata in 1904 and the renewed offer of his sons that they were prepared to endow the Institute with the full amount contemplated by their father that galvanised the Government into action. In 1906, the first Director of the Institute, Dr Morris Travers sailed for India to assist in the organization of the Institute. The Government of India issued a memorandum describing the scheme and detailing the assistance to be rendered by them which in the first instance amounted to a capital grant of Rs 2½ lacs, and a recurring grant of Rs 87,500. Thus was brought into being the Indian Institute of Science, and in 1911 the first students were admitted to the department of general and applied chemistry, under Prof. Norman Rudolf and electrotechnology under Prof. Alfred Hay. And soon the department of organic chemistry was opened and the students' quarters, and banglows for the

staff were ready for occupation. At the entrance to the magnificient senate hall of the Institute stands a noble monument, the statue of Jamsetji Tata, which will serve to remind future generations of his generosity and the persistence with which he worked for the welfare of India.

The vision of India as the home of prosperous industries was always before his minds' eye, and he early realised that such development was possible only on the basis of fundamental key industries like that of iron and steel and on the supply of abundant and cheap power. The later two great enterprises of his firm, the iron and steel works at Jamshedpur and the three hydro-electric projects in the Western Ghats were both fostered by his great ambition. It was he who made the Imperial Government interested in both these schemes. Neither paid a pennypiece to him during his life-time, and he financed all the preliminary investigations.

Ever since his association with Nagpur Mr Tata became interested in the mineral resources of the country and followed very closely the then much meagre records of the official and non-official geological surveys. The mining and prospective codes during the early part of the nineteenth century demanded thorough revision and he was very active in England to secure sympathy in this connection from the Secretary of State for India. His associates were in the meantime busy with prospecting in the Central Indian forests, with a view to finding out deposits of iron, coal and limestone — the three essential raw materials for the steel industry. After visiting industrial centres in England, Mr Tata proceeded to U. S. A. where he engaged Mr C. H. Weld on the advice of Mr C. P. Perin of the United Steel Corporation of Pittsburgh, America, to undertake the geological work which must be the initial step in planning a steel producing plant. On his return to India, Mr. Tata urged his son Dorabji to concentrate on the iron scheme for though his mind moved as vigorously as ever, he was no longer able to face the physical strain involved in this arduous task of exploration. In the summer of 1903, Mr Weld and Mr Dorabji Tata entered upon the adventurous wanderings and the privations of camp life in pathless jungles. Fifteen years earlier Mr P. N. Bose and surveyed the area and marked certain areas rich in iron. Mr Weld and the other geologists were satisfied with the quality and extent of the deposits of iron ores in Dandi Lohara district to which they came following the map prepared by Mr Bose; and the site for the factory was chosen to be Padampur near Sambalpur in Orissa which lay between the Dhalli and Rajhara, deposits and the Jharia coal field and had abundant water supply from the Mahanadi river. But a letter from Mr P. N. Bose, who had in the meantime retired from the service of the Geological Survey of India and entered the service of the State of Mayurbhanj as Geologist, followed by the Maharaja's appeal altered the earlier plan of location. The iron-ore beds at the Gurumaishini Hill consisted of intensely metamorphosed ancient surface flows. The ore, formed a solid cap on the tops of the mountains, and covered the slopes in the form of larger and smaller stones and float. The cost of mining was therefore very low. Competent observers indeed consider this deposit as one of the mineral wonders of the world, as it contained no less than 69% of the metal. The firm came to terms with the Maharaja of Mayurbhanj, who treated them with great consideration. He agreed to allow them to take ore for the firsc three or four years without any royalty, and then to charge a royalty beginning at half anna per ton, and gradually rising to 8 annas per ton. The average royalty works out over a term of fifty years at 3½ annas per ton. The lease which was ultimately granted by the Maharaja covered an area of 20 square miles. This quick decision to transfer the site of the iron works from Sambalpur much farther east to Sakchi on the Subarnarekha river was characteristic of the foresight of the Tatas. The success of their scheme depended on the coast of transport of their products to the port of Calcutta and still more upon the cost of assemblage of iron ore, coal and limestone at their works, and Sakchi (now Jamshedpur) proved an ideal spot for this purpose.

In the summer of 1906 Mr Dorabji and Mr Padshah worked hard in London to raise the funds for launching this great scheme, but met with scant response. English capital was obviously distrustful of the whole scheme. Some British financial firms which were approached proposed terms which would have meant virtual absorption of the Tatas by them. Fortunately however the Swadeshi movement was then at its height in India, following in the wake of the Partition of Bengal. And the Tatas published a prospectus of their great scheme and issued an appeal to the 'Swadeshi' sentiment of the Indians. The response was instantaneous. " From early morning till late at night, the Tata offices in Bombay were besieged by an eager crowd of investors. Old and young, rich and poor, men and women, they came offering their mites; and at the end of three weeks,

the entire capital of two million pounds was secured, every penny being contributed by Indian ".

The first stake was driven on the plateau of Sakchi in the midst of jungle on February 27, 1908 and the first iron was made in December, 1911. Today we have there a township of more than 150,000 people; and not only the Tata Iron and Steel Company have been expanded beyond recognition, but Jamshedpur has become the home of many large-scale associated industries.

" Mr Tata was also interested in hydraulic power from the falls at Jubbolpur where the Nerbudda river rushes between the famous marble rocks as early as 1875, while looking for a site on which to establish the Empress Mills. But twenty years elapsed before he was able to give it a shape. In 1897 his enthusiasm in this direction was roused by Mr Robert Miller a merchant of Bombay, who was going to purchase the rigets over Doodh-Sagar Falls in the Portuguese territory. Mr David Gostling was employed to make an exhaustive report of the possible use of the power for commercial purposes. On a favourable report a syndicate was formed. Mr Gostling afterwards as a result of his holiday visits to a hill station on the Western Ghats, was convinced that the configuration of the land provided an excellent catchment area, and that the storage of the rains could furnish a considerable portion of the energy required to drive the mills of Bombay. Encouraged by the success of a scheme at the Cauvery Falls, Mr Gostling expounded his ideas to Mr Tata who immediately grasped their great possibilities. The Doodh-Sagar Syndicate was temporarily set aside and attention was concentrated upon this more promising area.

As soon as the preliminaries of the scheme had been formulated, Mr Tata approached the Government in order to secure priority for the necessary concessions: the acquisition of the land, and the licence needed for a public project. Before taking any definite steps, he went to London and saw the Secretary of State for India, Lord George Hamilton, to whom he expounded his schemes. Lord George was decidedly sympathetic, and on returning to India Mr Tata found that the support which he had evoked proved a valuable asset. Before the syndicate could be definitely launched there were two important points to be settled. One was the acquisition to the necessary rights over the land, the other was the formal recognition of the new venture. It was necessary that the Bombay Government should permit the enforcement of the Land Acquisition Act, in order to enable the Combany to acquire property for what was accepted by Government to be a public purpose. The hydro-electric project, needing sites for the reservoirs and works, involved the destruction of acres of forest, the absorption of some thinly populated valleys.

The Syndicate was later enlarged and Sir Dorabji was taken in. Shortly after Mr Jamsetji's death a syndicate was formed in London, to sift the prospects of the scheme. In 1905 Dr John Mannheim, the electrical expert for Messrs. Alfred Dickinson and Co., of London and Birmingham, came to India to investigate the hydro-electrification of Lahore. He heard of the Lonavala project, and was so interested that he visited the Tatas on his arrival in Bombay. A fortnight later he carried away from the old syndicate, which included Mr Gostling and Mr Edward Miller, the option to float the new syndicate incorporated in London, the Bombay Hydro-Electric Syndicate, Limited. They appointed his firm as consulting engineers. But after much cautious survey and planning, covering three strenuous years, the London Syndicate failed to find sufficient funds, in spite of the help which came from some prominent millowners who guaranteed to underwrite a substantial amount. And a financial crisis in America deranged the money matters of the whole world. In June 1910, however, Lord Sydenham while opening a cotton mill at Sholapur, exhorted his audience to invest their money in this excellent hydro-electric project for Bombay. The speech sowed the right seed. The natural caution of the Indian investor gave way to national pride. On November 7, 1910, The Tata Hydro-Electric Supply Company Ltd., was registered as a public concern. First power was switched on Feb. 11, 1915.

Power upon so extensive a scale became a distinct advantage to the industries of Bombay. Not only did the textile trade gain considerably by cheap electrical energy, but its extension was facilitated; while the establishment of new industries, both within the city and adjacent to the new lines of transmission was made an easier matter. So much so, that the original Lonavala project generating 40,000 H. P. at an initial cost of 2 crores of rupees soon proved inadequate; and in 1906 a new hydro-electric scheme at Khopoli was planned to generate 60,000 H. P. at a cost of 3½ crores of rupees. This too in its turn proved inadequate and the Nila Mula project was undertaken by the Tata group of companies, intended to generate 180,000 H. P. from the waters of an artificial lake 16 square miles in area at a height of 1800 ft from the power station at Bhira.

'If Mr Jamsetji Tata were alive today and could look upon the achievements that have resulted from the original scheme he visualized at Lonavala, he would have the satisfaction of knowing how faithfully and earnestly his successors have striven to carry forward logically the great work that his foresight had inspired. From his death-bed he extorted those who followed him to preserve the name of Tata and to pursue and extend his work. His sons and successors have done so and their story is in part his. The brunt of the organization fell upon men like Sir Dorabji Tata, his cousin Sir Ratanji Tata, Mr Padshah, and Mr Bilimoria. They had already won their spurs under Jamsetji's guidance, and they in their turn have gathered round them a band of young Indians who have carried on the traditions and have preserved the veneration for the founder which makes them feel like members of a single family."

The centenary celebrations of his birthday would be an inspiration to those who are ambitious, for they serve to remind them of the achievements of the man who conceived and brought to fruition so many great Indian enterprises—to those who are philanthropic and find that it is often more difficult to spend money usefully than to earn it, and to that vast army of patriotic Indians who are trying today to harness the energy and ability of this wonderful nation for constructing the broadway of freedom and prosperity.

The name of Jamsetji Tata will go down to posterity, not only as the greatest of Indian pioneers in large-scale industrialisation of India, who stole the thunder from British business, but also as a great educational philanthrophist. In fact, he can rightly be styled as the 'Andrew Carnegie of India,' but unlike Carnegie, he was not spared long to see all his projects in full bloom, and to direct the administration of his 'charities' to the most fruitful lines.*

*Most of the materials for this account have been gathered from Mr F. R. Harris' book on J. N. Tata.

Steel Industry at Jamshedpur

J. J. Ghandy
General Manager, Tata Iron and Steel Co., Ltd., Jamshedpur.

There are evidences of existence of the Iron Age in India about 1,000 B.C. or even earlier, and there are references to steel making and to the art of demasceening on soft steel in this country from 300 B.C. onwards. About the Middle Ages, we read of Persia importing steel from India, we read of the Saracens fighting with Damascus blades of Indian steel. Cnturies have passed since iron made its excursion into History, but instead of losing ground to other elements, iron and steel have steadily increased in importance. From them are fashioned a rich diversity of industrial tools and machinery and all manners of agricultural implements. Iron and steel that enter into railways, bridges, ships, aeroplanes, automobiles, telegraph, telephone and other electrical appliances are indispensable for defence purposes. They also furnish the framework of modern buildings and constitute the raw material for numerous articles of household use. In fact, iron and steel have penetrated so deep into the modern civilised life, that the present age has come to be labelled the Age of Iron and Steel.

Early efforts to produce Steel in India

It was Mr. Josiah Marshall Heath, who resigned from the Madras Civil Service in 1830 and set furnaces in operation at Porto Novo in South Arcot. In 1833, the Porto Novo Steel and Iron Co. took over the business and started new furnaces at Beypur on the Malabar Coast. But all efforts to produce steel proved unsuccessful.

In 1853, a new firm called the East India Iron Company, announced its existence, with a capital of £400,000, erecting a blast furnace in the South Arcot district and another on the Cauvery river. But failure attended this enterprise as well.

In 1875, Barakpur Iron Works came into being, but were obliged to close their doors in 1879 and were taken over by the Government in 1881 and transferred in running condition to the Bengal Iron and Steel Company in 1889. In 1919, the Bengal Iron Company sprang into existence and piloted the industry to success. But the dawn of steel was still to come; it awaited the arrival of that great industrial genius, the late Mr. Jamsetji Nusserwanji Tata who not only founded the Empress Mills at Nagpur and three hydro-electric works near Bombay, but also the Tata Iron and steel Works at Jamshedpur, which constitute today the largest single steel producing unit in the British Empire.

Steel Industry at Jamshedpur

It will be a long tale to refer to the resoluteness and energy with which the late Mr Tata worked in collaboration with two American engineers, the late Dr Charles Page Perin and Mr C. M. Weld, to bring into existence the iron and steel industry in India. He conceived and pursued his ideal in the face of every variety of failure with no confusion or loss of direction, and the struggle was continued by his successors who had to wander through the jungles of the Central Provinces, bearing the heat and the burden of the day in vain search of iron deposits. It was afterwards due to the efforts of that famous Indian geologist, the late Mr P. N. Bose, that rich deposits of iron ore were discovered in the Mayurbhanj territory and that it was only after protracted appeals to national sentiment, that the necessary capital was secured.* The next pro-

* Mr. F. R. Harris in his chronicle of the life of Jamshetji Nusserwanji Tata describes the situation as follows: "****Experts reported very favourably upon the quality of the ore, satisfied themselves about the immense quantity available, and expressed the view that it could be cheaply converted into pig iron and made into high-grade steel. At this stage, which was reached in the spring and summer of 1906, the project flagged again. A preliminary prospectus was prepared and submitted to various financial interests in London, but unforeseen difficulties were encountered. There were differences about the degree of control which was to be entrusted to the representatives of English investors. A disposition seemed to be manifested to sweep the Tata firm aside. Far more disconcerting was the lack of interest shown by the London Money Market, which is always ready to pour capital into China, or Patagonia, or Timbuctoo, but shows a traditional unwillingness to invest in new enterprises in India. Mr. Dorabji and Mr. Padshah, acting for the Tatas, had, moreover, come into touch with London during one of its periodical phases of depression. Money was very 'tight,' and all fresh projects were looked at askance. The sum asked for was very large. It would have met with a doubtful reception at that moment had the works been projected for

blem that awaited solution was the selection of a suitable site for the steelworks. The Tata Iron & Steel Co., which had announced its existence in 1907, with Messrs. Julian Kennedy, Sahlin & Co., as its construction engineers, selected Sakchi for this purpose on account of its nearness to iron ore, coal and limestone supplies; its command of water and rail road facilities, its comparative closeness to the port of Calcutta, and on account of mica schist that underlay the site, furnishing a suitable foundation for the erection of a steel plant.

The actual construction at Jamshedpur commenced in 1908, four years after the great originator of the scheme, Mr J. N. Tata had passed away, under the able guidanace of his eldest son, the late Sir Dorabji Tata. The first pig iron was produced towards the end of 1911 and the first steel ingot being rolled off the blooming mill on the 16th February, 1912.

England; being for India, people buttoned up their pockets. Eventually there was one exciting period when about four-fifths of the required capital was actually promised; but the Syndicate fell through, and the enterprise again seemed doomed, and Mr. Dorabji returned to India.

For more than a year the negotiations were continued in England but never with more than partial success. By the summer of 1907, however, a new situation had been created in India. The 'Svadeshi' movement, which on its more praiseworthy side meant the cultivation of the doctrine that the resources and the industries of India ought to be developed by the Indians themselves, had reached its height. All India was talking 'Svadeshi', and was eager to invest in 'Swadeshi' enterprises.

Mr Dorabji and Mr Padshah, who had spent weary months in the City of London without avail, after their return conceived, in conjunction with Mr Bilimoria, the bold idea of appealing to the people of India for the capital needed. The decision was a risky one, and many predicted failure, but it was amply justified by the result. The issued a circular, which was practically an appeal to Indians. It was followed by the publication of a prospectus, which bears the date August 27, 1907. Mr Axel Sahlin, in a lecture delivered to the Staffordshire Iron and Steel Institute in 1912, has described the instant response. He says:

"From early morning till late at night the Tata Offices in Bombay were besieged by an eager crowd of native investors. Old and young, rich and poor, men and women, they came offering their mites; and, at the end of the three weeks, the entire capital required for the construction requirements, £1,630,000, was secured, every penny contributed by some 8,000 native Indians. And when, later, an issue of Debentures was decided upon to provide working capital, the entire issue, £400,000 was subscribed for by one Indian magnate, the Maharajah Scindia of Gwalior."

Stages of Steel production

Coal obtained from the various mines is first pulverised in the crushers and then taken to the coke ovens, where it is heated in air-tight chambers and converted into coke, the gas that escapes from the coal during the process of distillation being utilised for heating and drying purposes.

Almost all the coke obtained from the coke ovens, mixed with requisite charges of iron ore and limestone, is then hoisted in skip cars to the top of the blast furnace which is sealed by two movable "bells", the raw materials occupying the space between the open top bell and the closed bottom bell. The top bell then closes and the bottom bell opens, so that the charge

Top of the blast furnace.

descends in the furnace and meets ascending currents of heated gas which is merely air superheated in stoves and blown in through openings in the bottom of the blast furnace. As a result of contact with coke, this superheated air is transformed into gas, and the raw materials, whilst descending, are reduced and melted, lime-

stone acting as flux and absorbing the various impurities from the ore and forming a slag which is tapped from the furnace through a hole known as the slag hole, the molten metal which is heavier than the slag being tapped later.

The pig iron obtained from the blast furnaces, is utilised chiefly for steel making, although a small portion of it is also cast into sand beds or into moulds at the pig casting machine and sold outside for foundry use.

The two processes used for the conversation of pig iron into steel are the Basic Open Hearth and the Duplex Process, of which the former uses both pig iron and scrap and the latter pig iron exclusively, the object of both processes being the purification of pig iron.

In order further to distinguish the two processes, it may be mentioned that whereas in the open hearth, the purification of pig iron is effected entirely in the open hearth, in the Duplex process the molten is first "blown" in an acid Bessemer converter for removal of impurities like silicon, manganese and carbon, before it is subjected to the purifying process of the open hearth, where phosphorus is eliminated to a great extent and the requisite metals added in suitable proportions so as to yield steels of correct specifications.

The molten steel obtained from the open hearth or the Duplex plant is then transferred into moulds and allowed to solidify into what is known as ingots, and then taken out of these moulds and removed in trollies to heating furnaces to be heated to the required tempearture. The blooming mill reduces ingots to blooms and slabs, slabs being rolled into plates in the plate mill and blooms into rails and structurals in the rail and structural mill, or into sheet bars, billets, sleeper bars and tin bars in the sheet bar and billet mill. The sheet mills convert these sheet bars into sheets; the merchant mill turns the billets into merchant bars and light structurals; the sleeper press presses the sleeper bars into sleepers; and the Tinplate Company, which is situated only 2 to 3 miles away from the Jamshedpur Steel Works, transforms the tin bars obtained from the Steel Company, into tinplates.

Organisation of the Tata Iron & Steel Co.

The ultimate responsibility for the management of the Company is vested in Messrs. Tata Sons, Limited, who are Managing Agents, deriving their authority from the powers delegated to them by the Board of Directors of the Steel Co. The Managing Agents in turn have delegated some of their powers to the General Manager of the Company who controls the organisation in Jamshedpur and co-ordinates the work of the numerous departments working under him.

The following is the list of the Divisional and Departmental Heads who are under the control of the General Manager: -

(1) The General Superintendent (Works).
(2) The Controller of Accounts,
(3) The Chief Engineer,
(4) The Genl. Superintendent, Ore Mines & Quarries and Prospecting,
(5) The Coal Superintendent,
(6) The Chief Town Administrator,
(7) The Chief Medical Officer,
(8) The Labour Officer,
(9) The Superintendent, Labour Bureau,
(10) The Superintendent of Training, and
(11) The Purchasing Officer.

The labour employed by the Company is either of parmanent or of a temporary character, the strength of the former being determined by the permanent, basic requirements on the Steel Company, and that of the latter varying in accordance with demand for the Company's products in the Indian markets as well as with the capital construction programme that the Steel Company may have on hand.

The following figures will give a concrete idea of the number of workers of different categories employed by the Steel Company at Jamshedpur only, as on 1st. April 1938:—

			No. of men.
Superior supervisory staff			115
Other Supervisory staff ..			679
Clerks ..		..	1,425
Labour	Men	..	23,797
	Women	..	2,478
	Children (Office only)	Boys ..	780
		TOTAL	28,674

Adding the number of workers who are engaged at the different mines and collieries, at the Agents' and Sales office, Calcutta, at the stockyards and at the Bombay Head Office, the total number employed works out to somewhere between 40 and 50 thousand, exclu-

sive of contract labour employed by contractors to carry out works on behalf of the Steel Company.

Amenities at Jamshedpur

If the steel industry is to have a permanent and a contented labour force, it must pay them a decent wage and provide them with amenities which add to health and happiness in general. As a consequence, the Steel Company is not only one of the best payers in India, but has also made itself responsible for such amenities as roads, drainage, sanitation, water supply, markets, schools, hospitals, and housing, the provision of which is not ordinarily the business of an industrial concern, but devolves upon municipalities or improvement trusts, the employees themselves and Government. Free medical treatment is provided both to employees and non-employees at the Company's hospital and at its out-door dispensaries.

rest house, free cinemas in the Bustees, play grounds for children, co-operative credit societies for the employees, a liberal provident fund and a retiring gratuity scheme. The new Profit Sharing Scheme which has recently been launched by the Steel Company is the first of its kind in India. It provides that when dividends payable to shareholders are in excess of a certain figure, the Company's employees will receive a certain proportion as profit-sharing bonus, the amount of which will vary with the figure available for distribution as dividends. Under this scheme, the equivalent of 3 months' salary was paid to the employees in the year ending 1937-38.

Research and Metallurgical Training

It is a matter of regret, however, that facilities for industrial research and metallurgical training, so essential to success in the steel industry, are utterly inadequate in this country. Contrast the major industrial countries of the West with India and you will notice a glaring difference in this respect. I shall single out only America for mention. There a special place is given by universities in their curriculum to subjects like engineering and metallurgy, and adequate facilities for research are provided; in addition, you have professional societies which enroll students as members, who later become Junior Members and then Full Members, and are admitted right from the beginning to all the transactions of the societies; you have also what is known as the Engineers' Council for Professional Development, members of which visit the different universities and scrutinise from time to time their courses of study.

View of the Bessemer converter.

Inside the Works there is a General Safety Committee, which is affiliated to the National Safety First Association and supervises the operation of the Safety Department at Jamshedpur.

Special stress has also been laid on the provision of adequate educational facilities for the children of employees as well as of other residents of Jamshedpur, no fees being charged in the lower primary classes, and every effort is being made to foster the ideal of universal literacy in the town.

There are several other amenities provided by the Steel Company such as free ice and soda for all its employees, Works hotels inside the plant, a women's

laboratory equipment and financial standing, and also prescribe courses of study to the students even after they have left the university. There are other media as well, through which the old technical men of experience are brought into touch with young students, and help the latter to improve their technical and metallurgical knowledge, both theoretical and practical.

Further, in order to assist qualified men in finding suitable posts in the steel industry, there are personal departments attached to various steel companies, to select candidates, after interview; steer them into different departments, and eventually give them suitable posts in the company.

These personal departments are also in constant touch with the various colleges and universities, and keep on the look-out for men of promise and ability.

Steel Industry in America

In the steel industry in America, whether you are going to work in a sales office or in the accounts or in the purchasing department, which appear on the surface to be non-technical, you have to attend technical lectures at night and do hard manual work in the steel plant for a certain length of time, and gain a good all-round idea of the plant in all its ramifications before you are started in the office.

It is worthy of mention that in that great democratic country, the United States of America, it is not the accident of one's birth or the class to which one belongs, that counts; the only thing that accounts is personality and merit. There have been instances of office-boys rising to be Presidents of Steel Companies,* and of some of the university men being left on the wayside. Hard work, integrity and conscientiousness are the strongest assets that a person can possess in any sphere of life; and if to these, is added the asset of a proper metallurgical and engineering training, there can be nothing to stop one from rising to the highest rung of the ladder.

* The great Andrew Carnegie, who gave 400 million dollars to charities, made his fortune in iron and steel industry; he was the son of a Scottish weaver, who emigrated to the United States to escape persecution at home. Carnegie started his life in a reeling factory, and earned 2s. 6d. as his first week's wages.

Forgive me if I recount my personal experience as a student in America. During a summer vacation, my professor at the Carnegie Institute of Techonology at Pittsburgh gave me a letter of introduction to the Manager of the Allegheny Steel Works, Bridgewill near Pittsburg.

I went to see him with this letter and acquainted him with my academic qualifications. This Manager who was chewing gum, spat on the floor and said: "These degrees are alright, but what the hell can you do?" Full of ambition, "Anything", I replied and was given the work of lifting timber in the sheet mills. In the beginning, I found that I could not lift more than one piece at a time, whereas my fellow-workers could manage 2 or even 3. After some practice, however, I was able to lift two pieces, and the Manager who was keeping a watchful eye on me, expressed his appreciation by promoting me to the post of a Helper, in the inspection section of the sheet mills, where I had to lift and pile sheets. Later on, I was made an inspector in supresession of the claims of several others, chiefly because I was a steady worker and had not been absent from work even for a day.

Facilities for Research and Training at Jamshedpur

The Tata Iron & Steel Co. Ltd. realised from the beginning that in the absence of adequate facilities for industrial research and for technical and metallurgical training in the country, it would not be possible for the Indian steel industry to keep abreast of recent advances in this field or hold its own against foreign competitors, and it was to meet this deficiency that the Steel Company set up the New Control and Research Laboratories at Jamshedpur, which were opened by the late Sir N. B. Saklatvala, Chairman of the Board of Directors of the Tata Iron & Steel Company, Limited, in October 1937. The laboratories will cost about twenty lakhs of rupees to the Company, when fully-equipped.

Further, the Company maintains a library, where a much larger number of technical or research publications are regularly received than by other libraries attached to other steel works elsewhere in the world. But situated so far away from America and Europe, which are the homes of research, the Company also considered it advisable to inaugurate an annual series of lectures last year in honour of the memory of the late

post-war depression and then through a brief season of prosperity, the industry found itself at the edge of the precipice during the world crisis that followed on the Wall Street crash of 1929. Thanks to protection and to measures of rationalisation, economy and efficiency which Tatas have been introducing from time to time, the industry was not only able to keep its head above water during those dark days, but has also been able to expand its output from year to year, as will be seen from the following figures:

Year.			*Tons of Saleable Steel.*
1933-34	..	..	531,000
1934-35	..	..	604,000
1935-36	...	..	646,000
1936-37	..	..	667,000
1937-38	..	..	660,000

The profits of the Company have also been on the increase, the nett figure for 1937-38 being Rs. 2,83,00000/- (Two crores and 83 lakhs) approximately, which constitutes a record.

I have no doubt that in view of the present strong position of the industry and the fact that this position can be utilised to strengthen its resources still further the industry will be able to dispense with protection after the expiry of the present period in 1941, unless unforeseen circumstances upset all calculations.

In a short time the Indian Iron and Steel Company near Asansol will also commence production of steel and although in the beginning they may have to engage a number of foreign experts as the Tata's did it may reasonably be hoped that they will gradually Indianise their staff, offering openings to the youngmen of this country.*

* Adapted on a lecture delivered under the auspices of the Calcutta University.